JOURNAL OF ELECTRICITY

POWER AND GAS

Devoted to the Conversion, Transmission and Distribution of Energy

Entered as second class matter May 7, 1906, at the Post Office at San Francisco, Cal., under the act of Congress March 3, 1879.

VOL. XXXIII NO. 6 | SAN FRANCISCO, AUGUST 8, 1914 | PER COPY, 25 CENTS

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JOURNAL OF ELECTRICITY
POWER AND GAS
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VOLUME XXXIII | SAN FRANCISCO, AUGUST 8, 1914 | NUMBER 6

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CO-OPERATIVE RATE MAKING SCHEDULES

BY WM. VAN DEN HEUVEL

(After a discussion of the several factors governing rate making and a criticism of the sliding scale, maximum demand, flat rate and readiness to serve schedules, a proposed co-operative rate schedule is analyzed by the author, who is a consulting engineer at Los Angeles.—The Editor.)

It is the purpose of this article to analyze in a general way the present methods of rate making, to inquire into the correctness of various rate schedules now in use, and to endeavor to show that present schedules or charging methods do not stimulate proper use of electric power, especially in undeveloped territory.

The ever present desire of the consumer to obtain electric power at a low price, demands that the consumer do his share in making this possible, and it is my object to advance arguments and facts in favor of a co-operative element to be introduced into the relation between the public utility and the consumer. As a matter of fact this element is now totally absent, and in order to have a real co-operative relation, and not one merely in name, it should become evident in the business that arises between the public and the company, as far as charging methods are concerned.

While from a legal or academic point of view it may be correct to term the relationship that of an agency or perhaps of a partnership, it appears in actual practice that such a relation is largely fictitious, surrounded by commercial conditions such as competition from other forms of power, and with public utility service requiring the sale of electric power as a commercial proposition.

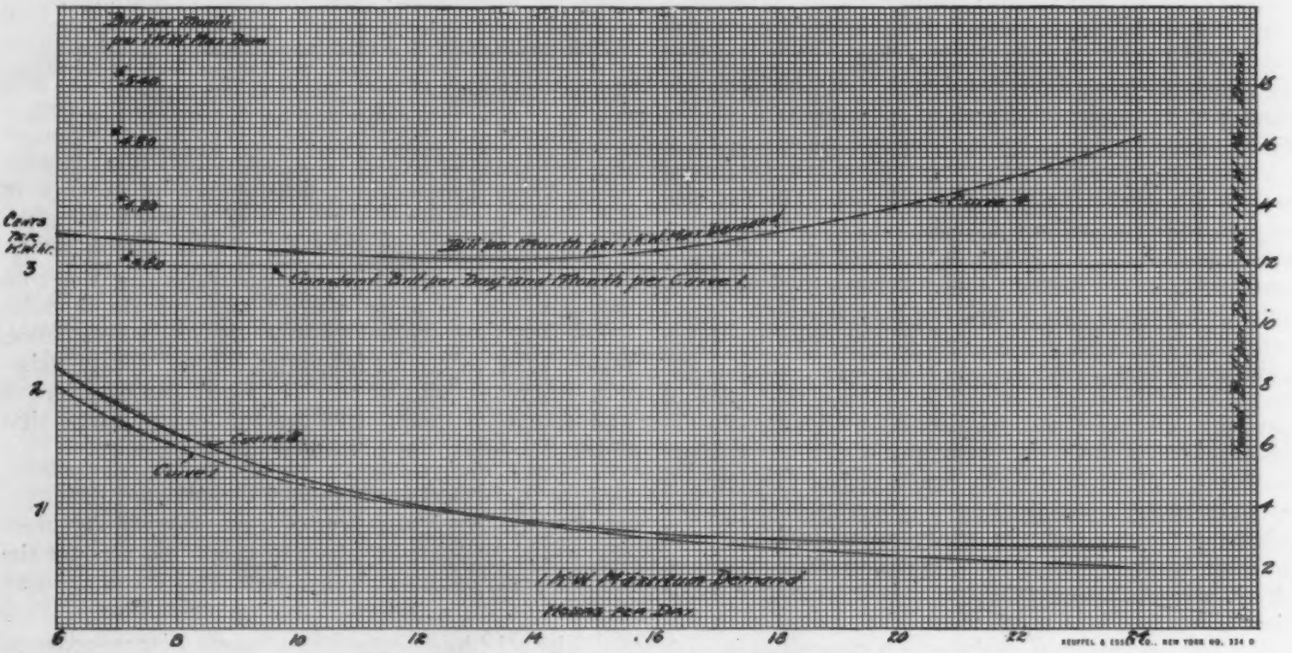


Fig. 1. Co-Operative Schedule for Irrigation Service.

A co-operative relation between the public utility and the consumer should allow of just discrimination in the rate charged, in terms of the conditions that have bearing upon the nature of the service. When, however for the sake of simplicity the law of averages is applied in the construction of a schedule, care should be taken that a too liberal and inconsistent use of this law be avoided as being an unjust discrimination against certain classes of consumers. The classification of various consumers should be simple

enough to allow of speedy accounting and simple rate making, but the sacrifice of fairness for the sake of simplicity should be reduced to a minimum.

On account of the complexity of the problems of rate making, I shall limit considerations here to rate making for commercial power and especially to power for irrigation purposes. We are, in this use of power, confronted with one of the vital problems of development of this Western territory. In providing this service, and, especially in acquiring the business, the power company is confronted daily with the competition of steam and gas-engine power, and in many localities the total pumping business is fairly well divided between the various forms of power.

As a matter of pure economics, it is preposterous that in small plants the steam or gas engine can compete with electric power furnished by a power company. Yet, we know this to be the case and it remains to analyze this condition of affairs. The farmer when ready to put in a pumping plant, listens in turn to various salesmen and to solicitors of the power companies. However, only superficial study is made of the exact nature of his conditions. In almost every instance the proposition is one of obtaining a cheap plant that will produce water at a cost somewhere within reason. Investigation of the conditions is limited by the cost of such work, and even when the purchaser does see the advantages that might result from a careful study, the engineer whom he employs to look into the matter soon finds that purchased electric power is under decided limitations and that the schedule does not recognize the method of operation of the plant.

It is not reasonable to expect a low rate for power unless the conditions of use warrant it. The exercise of an intelligent judgment in the selection of pumping equipment, its size and the duration of the periods of operation, are all matters that are concerned with the rate that should apply, and the rate schedule should reflect influence of the method of use upon the price paid for power.

The problem of devising such rate schedules in equity to all concerned, requires a broader conception on the part of the power company of the scope of its business. While in the past we have had evidence, in some cases, of the willingness on the part of the power company to give thought to irrigation problems and to offer to the farmers rates that suit their business, these rates do not contain proper inducement to cause the farmer to adopt more economical irrigation methods. The organization of the power companies is such that it could easily permit of a department that would study irrigation from a broader viewpoint, and that would ascertain the best methods of use in various districts for the purpose of giving cheaper power produced at a lower cost.

Efforts in this direction will engage the co-operation of the farmer as a matter of course, and will create a relationship between the public utility and the public now absolutely unknown.

For the purpose of more clearly bringing out the advantages of co-operative schedules, a short discussion of existing schedules is desirable.

Sliding Scale Schedule.

The so-called cumulative sliding scale schedule as used in this part of the country, does not contain material recognition of some factors that enter into the use of the service rendered.

It represents a successful attempt on the part of the power companies to provide a means for finding charges that must be billed to the customers, with due compensation for conducting its business as a whole. The simplicity of this schedule is commendable, but it has been obtained at the sacrifice of fairness in individual cases, when taking into account the conditions as they exist on the premises of certain consumers. It is not intended to convey by this statement that the rate charged is unfair, but rather that the schedule is not adapted for its purpose, namely, of giving a means of fairly charging a number of consumers of a certain description or class. If we, by the application of the law of averages, make the efficient user, under this schedule pay for the extra cost involved in serving the inefficient user we are making an unfair discrimination.

The sliding scale schedule stimulates primarily the installation of large plants, or rather the concentration under the same ownership of large horsepower capacity in motors. It does this regardless of the method of use, and limited only by the usual minimum charge per h.p. per month. It is not logical that the mere combination of the loads due to a number of motors in close proximity of each other should command a materially lower rate than the individual consumers aggregating the same load, merely on account of the omission of metering and collection charges. Yet this schedule uses such discrimination.

Though the statement may seem exaggerated, it is a fact that the sliding scale schedule, while favoring large motor installations, discourages by absence of sufficient compensation by way of a lower rate, systematic and efficient use on the part of the consumer.

In other words, it is often cheaper for the consumer to put in more motors, and operate them at times and in a manner suiting his own convenience, rather than to contemplate the further use of existing motors, perhaps at specified times and over longer periods. It is again only the minimum charge that limits him in adding additional motor capacity.

Maximum Demand Schedules.

The so-called maximum demand schedule, often also called load-factor, schedule, takes into account the consumption of energy per month per 1 kw. maximum demand on the premises of the consumer.

The schedule recognizes to some extent, economical use of the power by charges that grow less with increased use per 1 kw. maximum demand per month.

It is this use of the month as the controlling period in the establishment of the load factor, and of the charges applicable under the schedule, that is not in accordance with the natural cycle of use by most consumers. We note, for instance, that it is immaterial under such schedule whether 1 kw. maximum demand is used for 30 days per month and 12 hours per day, or for 15 days per month and 24 hours per day. The consumption per 1 kw. maximum demand is in each case 360 kw. hours, though it is evident that there is a considerable difference, both as to the cost of providing the service, and as to the value of same to the consumer.

Flat Charges.

Some of the power companies who have recently attempted to introduce new charging methods for some of their irrigation business, offer a flat rate per h.p. per year as best fitted to irrigation service. The rate thus offered charges the consumer $50 per year for each 1 h.p. maximum demand as measured in the output of the motor. It is the intention to promote, by this rate, all year around use of the power and on a uniform basis and it compels the farmer to install a reservoir and to resort to night pumping in order to get down to a low rate.

No doubt this method of charging is preferable to any of the previous methods, but in my opinion, does not do justice to the facts. The method works an unnecessary hardship on the district as a whole, and requires the installation of a reservoir capacity larger than would be the result of joint operation of the district by all farmers combined. In other words, the flat rate schedule causes the farmer to go farther in producing uniform use on his own premises in order to obtain cheap water, than would be necessary in a co-operative sense, with the power company as one of the parties. The power company's system of distribution, permits by means of diversity, of a smaller aggregate reservoir capacity for the district, and a co-operative schedule would not compel, but merely induce, continuous use of power. By placing the benefits of diversity within the control of the consumer himself, co-operative effort will be the natural result, and the same or even better results will be obtained with less investment in reservoirs.

Readiness to Serve Schedules.

These schedules, also called Doherty schedules, are based upon a correct analysis of the costs of rendering the service. The application of the schedules to actual practice is difficult, and introduces complications that are not warranted by the results. A segregation of the various expenses into consumer, demand and output expenses, is absolutely in accordance with the variations that will exist in the form of use by different consumers, and as will be noted later the co-operative schedule, proposed hereafter, is based upon these factors, under application of the law of averages, but with the one difference, that it gives a constant rate to any one consumer, as long as his method of use does not vary more than a fixed percentage from that whereby his original classification was determined.

In commercial power in general, and in irrigation as well, a day is the smallest commercial cycle in operation. Therefore, the method of use or non-use of 1 kw. maximum demand during 24 hours should be the basis of any schedule rather than the month. Additional factors may account for the variations of the use over the month, and others again for variations over the year thus indicating seasonal variations.

It hardly conforms to present accepted thought on the subject of charging methods to advocate a complication of the schedules for the sake of promoting the interests of all concerned.

May we not, however, in justification of such complications point to railroad freight tariffs and to the maze that they convey to the layman, while advancing the claim that the complications of a schedule are unavoidable, inherent to the business and desirable from every point of view, excepting perhaps that of simplicity.

In order to do full justice to all facts that have bearing upon rates or schedules for any one class of service, and in this case for irrigation service, we must take into account the inter-relation of lighting and commercial power service. This applies especially in large unified systems such as are now operating in Southern California. The mutual influence of the use by different districts, communities and consumers of different classes, the diversity of use, or in general, the non-coincidence of peak loads due to all consumers under the system is directed by the power company to produce better service and lower rates, such as would not sustain an isolated business of smaller proportions. The commercial features of the processes of unification of the large systems have brought about enormous systems of transmission and distribution over which energy is shifted in accordance with the demand, and in view of the fact that considerable parts of these systems were smaller isolated system at one time, the tendency has been to have more distributory equipment than would be installed now if the entire system were to be reproduced at this time. In the meantime, we have the means, by a more intelligent and specified use of the service to minimize future additions to existing systems, thereby reducing the investment upon which returns must be earned.

Distance, under present acceptance by the decision of the railroad commission, is not allowed as a factor in the establishment of rates for different districts, and we have in this decision a splendid application of the law of averages, and also of the introduction of a co-operative element into rate making. When it is realized that judicious application of the law of averages underlies the very principle and success of co-operative methods, it is evident that a co-operative schedule may contain a considerable measure of application of this law, provided that it does not introduce unjust discrimination. Instead of applying the law to the method of use as is now clearly the case in all existing schedules, it is more equitable and more clearly within the meaning of co-operation, to apply this law to various consumers, eliminating the size distinction that now prevails. The size of the consumer should not be as important a factor in determining the rate to which he is entitled, as is now the case in most schedules. While it is a fact that the investment per 1 kw. maximum demand required for service on the premises of a consumer becomes less with increased size, it is not in a proportion as now accepted, and furthermore, the law of averages applied to size would still do justice to the total investment as incurred by the power company.

In accordance with the above, it is proposed to obtain a condition whereby under equivalent methods of use, a 10 kw. consumer and a 100 kw. consumer will have a different rate for the service, only to the extent of a difference in the average investment per 1 kw. maximum demand.

The power company with a definite number of kw. maximum demand available in its generating plants, and with a given distributing system, is confronted with the problem of approaching ideal operating con-

ditions represented by the sale of this maximum demand for 365 days in the year, 24 hours per day. Its business-getting methods are directed to show a fair profit on the total amount of business done, and the volume of the business is subject to enlargements by means of improved load factor and diversity. The consumer now takes no part in these efforts and the company has the exclusive use of the means to improve the methods of providing the service. The system of charging for service is essentially quantitative, and admits of the quality of the use in remote degree only.

Proposed Co-operative Schedules.

A more perfect system of charging must recognize both quantity and quality of service, and the schedule submitted (see Fig. 1 and 2) herewith is

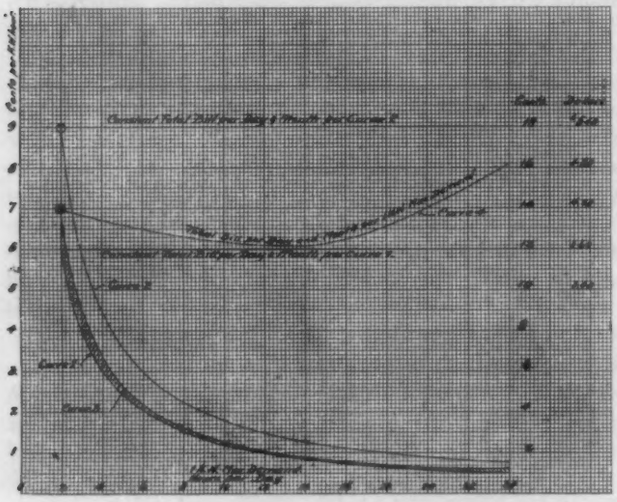


Fig. 2. Proposed Co-Operative Rate Schedule.

proposed as containing the basis upon which such discrimination between consumers may be made. The unit values adopted as the basis for the schedule shown, are tentative only, and may be made to vary in accordance with the conditions of service for which the schedule is intended. The lower curve represents the charges per kw.-hr. for various periods of use per day, while giving a constant return per 1 kw. maximum demand of $3.60 per month or $43.20 per year. The curve shows how the cost would have to vary in a water power plant system, if it is assumed that the output costs are more nearly constant regardless of the amount of use. Every modern power system that uses water power, also operates steam plants in conjunction, and the combination causes the company to be put to certain added expenditures under increased use per 1 kw. maximum demand. While the variable or output expense is a minimum, under the least use per day, the charges on account of the investment are constant, regardless of the use, but the rate per kw.-hr. increases because it is the only means whereby the power company can collect the total charges incurred in rendering the service. Curve 3 is a correction of Curve 1, introducting the fact of the increase of charges due to increased use per day. Curve 2 is the theoretical curve based on a constant return per 1 kw. maximum demand of $5.40 per month, or $64.80 per year. The field of correct charges will for most practical purposes be within the area represented between the two Curves 1 and 2, and Curve 3 is intended as an average that would apply for actual charges, as illustrated and discussed in this article.

For the purpose of showing graphically the variation of the total bill per month per 1 kw. maximum demand, a Curve 4 has been drawn showing such bills for different periods of use per day. It is the general form of this curve that controls the business of the power company as a co-operative institution. It will be noted that the curve shows a minimum bill for a use of the service during 12 to 14 hours per day; that for both shorter and longer hours of use the bill increases. On first thought a charging method that charges more for less use seems erroneous, especially if we view the method from the angle of what happens in a small isolated plant. In analyzing the method from that point of view, our premises, however, are wrong and we must bear in mind the co-operative element of the utility service, in order to see the justice of the method as proposed here.

It must be remembered further, that this schedule is not intended to apply to a consumer for the purpose of determining what his bill shall be each month. The schedule is intended to serve as a basis upon which power may be canvassed and contracted for, and to enable the power company to state, in terms of the conditions of use of the particular consumer, what his rate shall be once and for all. The schedule is to be used for classifying purposes only, and the rate per kw.-hr. given to a given consumer is constant for the amount of energy used by him during the month. The following is intended as an outline of the method of use of the schedule.

Upon application by a customer for a connection, a blank is filled out giving the detailed conditions of the service required. From this data an estimate may be made of the probable maximum demand, the time of its occurrence, and the hours of active use per day of the connection. The customer is then given a classification and notations are made of all details of the method of use and this introduces automatically all questions of daily, monthly and seasonal variations that may be expected in the use of the service. The original classification is now made subject to corrections, that cause the rate derived from the schedule to become increased in terms of irregular use, or reduced if it is desired to obtain limited power, during off-peak hours only, in relation with other consumers, etc.

It is evident that all estimates should be subject to verification in actual service, and the consumer may install devices measuring the maximum demand or tracing the load, at his own expense if he desires it. The recording watt-meter as now used, would still remain the means of measuring the total amount of energy used during the month, and when multiplied with the established flat rate for the service per kw.-hr. would give the total bill.

The customer does not need the incentive of a gradually decreasing rate per kw.-hr. during each month of increased use to cause him to make liberal use of the service. If, however, he sees a possibility ahead in the conduct of his business to increase his use of energy over certain periods, thereby qualifying for a lower rate, he will undoubtedly do so, and he should have the opportunity of doing so twice a year, demonstrating upon application his increased use of

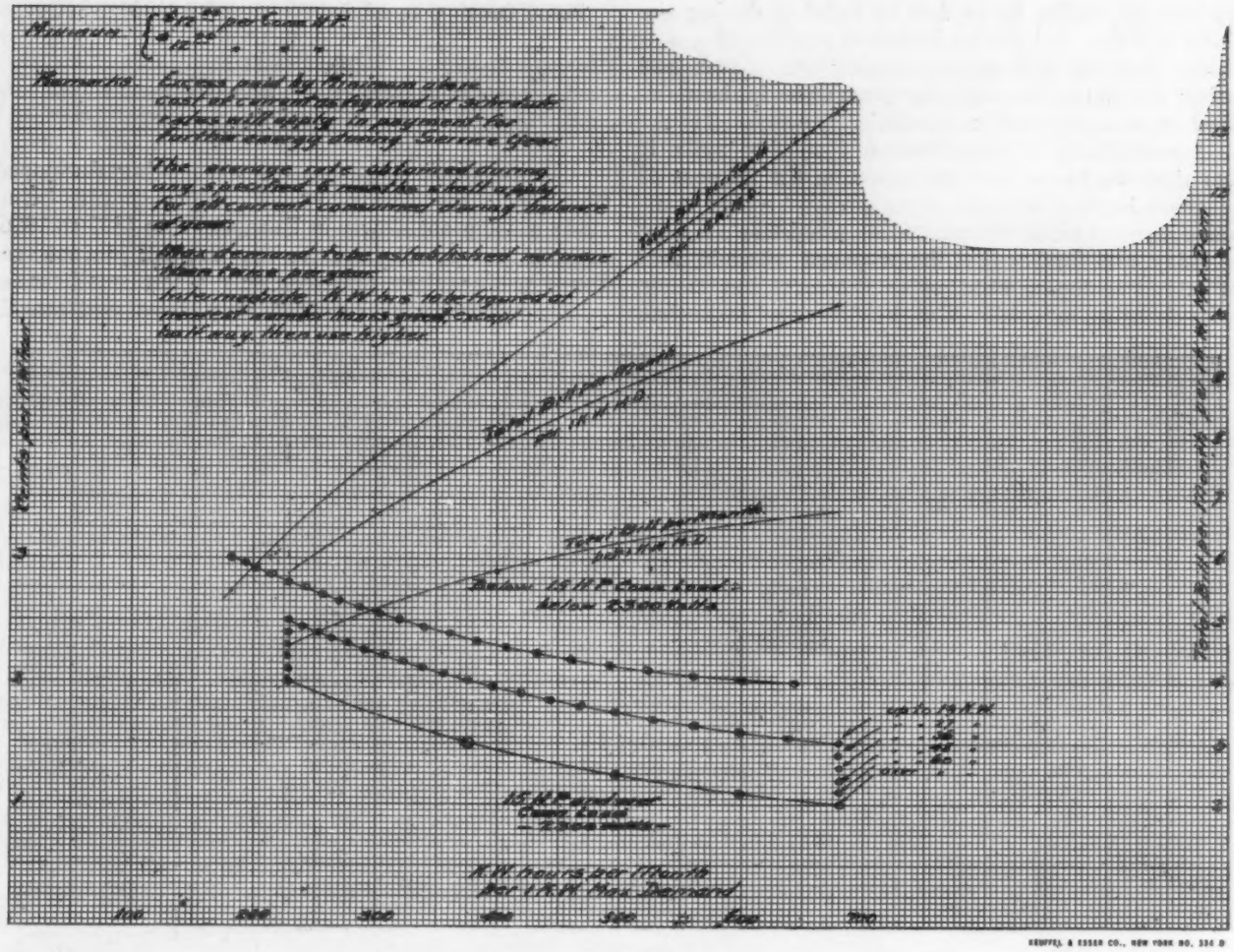


Fig. 3. Maximum Demand or Load Factor Schedule.

power The consumer should also be required to show the use of a fixed amount of energy each month, and at least within a reasonable percentage of the amount under which he qualified for the rate that he is being charged per kw.-hr. Repeated or systematic failure to use this given amount, should cause a higher rate to become applied to his bill, and he should lose all rights upon the original rate.

The above outline of the use of the proposed schedule shows that it serves to classify customers according to their method of use, and that therefore the fact that the bill for long hour users is smaller than for short hour users, does not lead to unjust or improper discrimination. To the contrary, it is in direct recognition of the influence of investment charges upon short hour users, as compared with the influence of output charges upon long hour users. Both long and short hour customers should receive the full benefits of diversified use. Therefore, for any one class of consumers we must introduce diversified use over the system as a whole. While everybody familiar with rate-making problems knows the effect of diversity, and knows the value of the so-called diversity factor, it may be opportune to make here a distinction between forms of diversity. The principal difference that I desire to refer to, is that of definite and indefinite diversity. The more definite that diversity becomes, the more service may be given by the power company per 1 kw. maximum demand in any part of the system. When we compare, for instance, the periods during which demand may be made upon the system by a residence and a pumping plant, we find not only that the period for the former is shorter, but also that the time of occurrence of the demand is more definitely known. The knowledge of this time of occurrence may be more or less definite, but in any case constitutes a means whereby the power company may claim an unearned income in view of the fact that the consumer wants unrestricted use of the service at all times. The mere fact that in actual operation this use becomes more or less defined, results in an advantage to the power company for which the consumer pays, and should pay, as long as he is not willing to define the time of use. Definite diversity should therefore be the aim not only of the power company, but of the consumer as well. Rotation of pumping plant operation, specified days and hours of use, either through or off the peak, are effective means of reducing the cost of power under co-operative methods.

No attempt will be made here to offer figures for the corrections that should be made in the base rate under the schedule, to allow for limited service, such as mentioned above, but there is unquestionably a set of corrections that would do justice to the facts. These corrections should be made, after all other corrections for diversity, due to the power system as a whole, have been made. I call attention, in this connection, to the seasonal diversity that is caused by the rela-

tive change in the loads due to lighting during the winter months, and the loads due to pumping for irrigation, that are a minimum during the winter and during the times that lighting places the highest demand upon the system as a whole.

Summarizing my conclusions, I wish to make it clear that the above does not question the fairness of the gross income earned by the present power companies upon their investments in properties as they are today, and further that the proposed schedule does not intend sweeping changes in the rates but rather in the charging method. Also, I believe and hope that I have shown that there is room for improvement in the relationship between the power company and the consumer, and that whenever the relationship becomes a co-operative one, important means will present themselves whereby more general and extensive use of power may be brought about. Finally, the co-operative schedule as proposed here will cause a more equitable distribution of the charges that make up the total gross income as derived from all customers under a system, and a gradual reduction of rates as the logical result of co-operative effort.

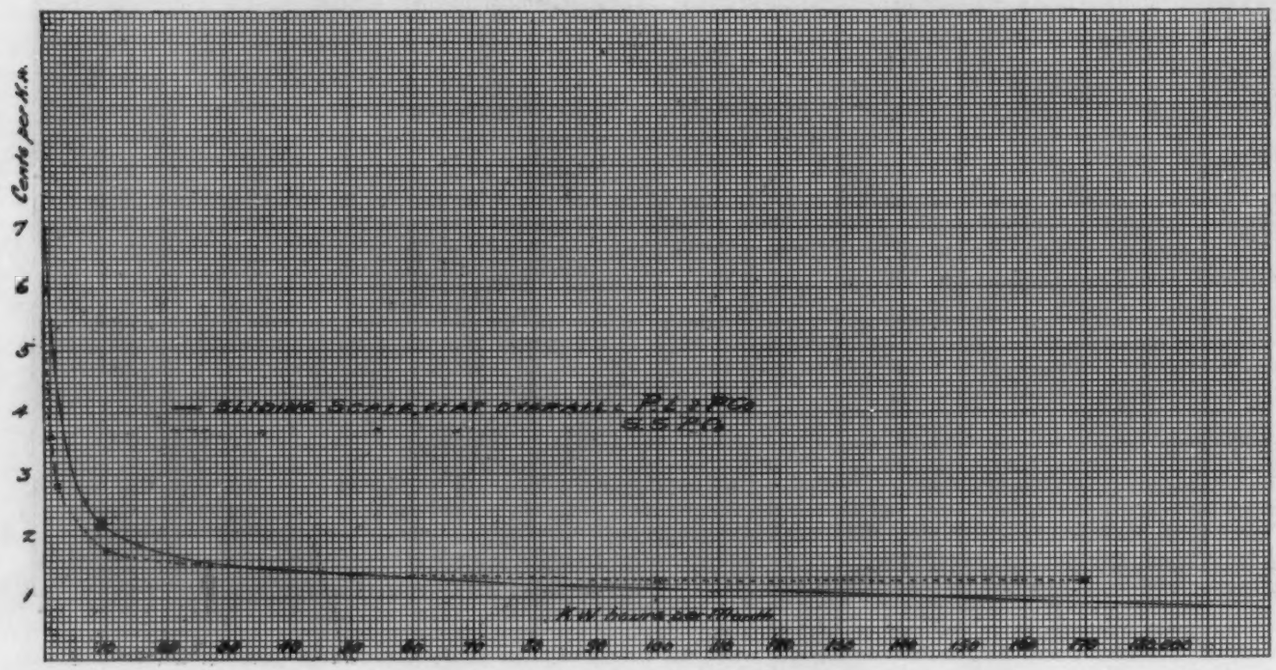


Fig. 4. Cumulative Sliding Scale Schedule.

Safety rules to be observed in the operation and maintenance of electric generating stations and substations, and on the overhead and underground distributing wires in connection therewith, have been prepared for publication by the United States Bureau of Standards. In this work the Bureau has consulted a large number of operating companies, workmen actively engaged in the different lines of work covered by the rules, as well as State industrial and public service commissions. The rules have been formulated so as to be complete and simple, and as easily understood as possible. It is believed that they will be of great value to State commissions, city authorities, and operating companies, and will tend to reduce accidents in this important industry.

HISTORY OF ELECTRIC TRANSMISSION.

BY G. O. WILSON.

[Continued.]

(This installment of Mr. Wilson's series is concerned with details of European and American progress from 1896 to 1900.—The Editor.)

While these large powers were being developed throughout the United States, progress was being made much more slowly in Europe. From 1891 to 1896, most of the power notes in the English journals referred to American practice; only a few small transmission plants were recorded in Europe, and practically no progress took place in England on account of the unreasonable obstacles placed in the way of promoters by the British Parliament, which body seemed to fear that if private capital were permitted to build up power projects, the various small, inefficient municipal generating plants throughout the kingdom would be put out of business. As an example of the lengths to which the authorities went in this obstructive policy, it is interesting to note that as late as 1902 there was a law on the English statutes prohibiting the transmission of more than 1000 kw. of energy over a single line.

On the Continent, progress was also slow, only a few power stations being in commission in 1896, the date of the opening of the Buffalo transmission, which were on a larger scale than the very early plants of Tivoli and Locle already mentioned. In 1895 a 300 h.p. plant was installed near Genoa, Italy, the energy being transmitted 18 miles at 6000 volts d.c. In the same year a 1200 h.p. station, transmitting 6 miles at 4000 volts single-phase, was established at Neufchatel, in Switzerland. This was the earliest alternating current commercial plant of large size in Switzerland. The same year saw the first 10,000 volt a.c. line in France, 200 h.p. being transmitted 14 miles from the River Ardieres at this pressure, and early in the following year, 1896, the same voltage was reached in

Germany, where 255 kw. was transmitted a distance of 15 miles.

From 1896 to 1900 the industry of power generation and transmission went ahead in great strides in Continental Europe and America, although still practically dormant in England. In Europe, the step from 10,000 to 12,000 volts was made in 1897, when a plant at Steinamanger, Hungary, began transmitting 900 h.p. a distance of 38.4 miles at the latter pressure. The same high voltage was introduced in France, at Lancy, in 1898, the distance of transmission being only 25 miles. By the end of this year Switzerland also had a 12,000 volt line at Montboven, the current being single-phase, and a 6000 h.p. plant transmitting three-phase power 24 miles to Bozen at 10,000 volts. There was also practically completed at Kanderwerk a station to transmit 1800 h.p. 25 miles to Berne at the high pressure of 16,000 volts, three-phase, the highest voltage in Europe at that time. Italy was also beginning the development of its water powers, and early in 1899 the line from Paderno to Milan, a distance of 20 miles, was placed in commission, transmitting 13,000 h.p. at 14,000 volts, three-phase. The largest plant at St. Maurice, Switzerland, from which 10,000 h.p. was to be transmitted 42 miles to Lausanne at 25,000 volts d.c. under the Thury system, was almost completed in 1899; and in the same year the French plant at Locle was increased to 3200 h.p. capacity, and the voltage was raised to 14,000 volts.

While this progress was thus being made in Europe, during the four years from 1896 to 1900, great strides were being made in America, both in the United States and Canada. By the end of 1897 the full 15,000 h.p. was being developed at the Niagara Power Company's plant, and there was sufficient demand for power in Buffalo to warrant the construction of the second line on the vacant half of the original pole line. At the same time a contract for the seven other generators necessary to increase the capacity of the plant to 50,000 h.p. was let, and these were all delivered and in operation by the end of 1899. The beginning of a large addition to the power house in the gorge was also made in 1899.

The Canadian Niagara plant was still undeveloped at the beginning of the twentieth century; but many other large systems in Canada were well under way. Both Montreal and Quebec started in 1897 the large hydroelectric systems that were to grow up in the territory adjacent to them in the years to come; 10,000 h.p. was transmitted from the Richelieu River to Montreal, a distance of 25 miles, at a voltage of 12,000, two-phase. Quebec was supplied from two points. The first 3000 h.p. of a proposed 9000 h.p. plant at Lachine Rapids was installed during this year, and transmitted 5½ miles to Quebec at 4400 volts, three-phase; and 480 kw. was installed at Three Rivers and transmited 17 miles to the city at 12,000 volts. In the following year, there was completed at Hamilton, Ontario, the then longest and highest voltage line east of the Rockies; 2000 kw. was transmitted 35 miles at 20,000 to 24,000 volts, two-phase. In 1899, Quebec and Montreal both added to their power supply. At Quebec, 3000 h.p. was added to the Lachine Rapids plant, and a new power house was completed at the St. Gabriel River, the 1500 kw. generated here being transmitted 18 miles to Quebec at 20,000 volts, three-phase.

Near Montreal, a new power house was completed at Chambly; 8000 kw. was generated here, (with a proposed early extension to 16,000 kw.) and transmitted 16½ miles to Montreal at 12,000 volts, three-phase. Two other transmission lines built in Canada during this period are worthy of notice. The line transmitting 1500 kw. (with a proposed early enlargement to 3000 kw.) 32 miles from Kootenay to Rossland, B. C., at 11,600 volts, three-phase, is interesting because it was a pioneer in the rigorous climate of Western Canada. And a municipal plant transmitting 960 h.p. 18½ miles to Orillia is interesting because it was the first use of aluminum for transmission in Canada.

While these rapid developments were being made in Canada during these years, the United States was equally active, in many places besides Niagaga; 1897 saw several large California projects completed. At Bakersfield, 900 kw. was transmitted 25 miles at 11,000 volts. The Blue Lakes power house was started with a capacity of 1350 kw., and the power was transmitted at 2400 volts, two-phase, to a number of neighboring mines, the maximum distance of transmission being 17 miles. During the year also the work of building the 80 mile, 3000 kw., 33,000 volt line from Santa Ana to Los Angeles was begun, this being the longest in the world at that time.

Early in 1898, one of the most notable projects in the country was put into operation by the Pioneer Electric Power Company near Ogden, Utah. The 5000 h.p. generated at the power house of this company was transmitted 36 miles to Salt Lake at 28,000 volts, three-phase. This project enjoyed for a few months the record of the highest commercial voltage used in the world, but before the end of the year the 32 mile line from Provo to Mercur was put into operation at 40,000 volts. Experiments at 50,000 and 60,000 volts were made at Telluride, Colorado, during this year; but an iron telegraph wire was used, and the power transmitted was not in commercial quantitiy. In this same year, California had three new lines of importance, although not of as great dimensions as the above Rocky Mountain projects. The Newcastle-Sacramento line transmitted 800 kw. 28 miles at 16,000 volts; the Yuba-Marysville line transmitted 1080 kw. 18¾ miles at 16,700 volts; and the San Gabriel-Los Angeles line transmitted 1200 kw. 23 miles at 17,000 volts.

The year 1899 saw several large projects completed in this country. The Southern California Power Company's 81 mile line from Santa Ana to Los Angeles was placed in commission, and 3000 kw. was transmitted at 33,000 volts, and the line carrying 3000 kw. from Colgate 76 miles to Sacramento equalled the Provo voltage of 40,000. In Michigan, a 20 mile line from Allegan to Kalamazoo was used to convey 2700 h.p. at 25,300 volts. The Seattle line from the Snoqualamie Falls power house was completed, and 4000 kw. was transmitted over its 31 miles at 30,000 volts; the 45 mile Tacoma branch was also nearing completion. A 40 mile line from Blue Lakes to Stockton was also completed, and power was transmitted over it at 25,000 volts.

[To be continued.]

LIGHTING METHODS

AMUSEMENT PARK LIGHTING.

BY A. L. POWELL.

The managers of attractions at summer resorts have long sought a lighting equipment which would require little or no attention. The incandescent lamp was ideal in this respect, but heretofore was not available in large enough sizes to give the great efflux of light sometimes necessary for this class of service. Not only must the light be of a high intensity, but there must be a certain amount of brilliancy for best advertising value.

Recent changes in the construction of the Mazda lamp have materially improved the efficiency of light generation; have produced a whiter light, and made possible very high candlepower lamps with relatively small bulbs.

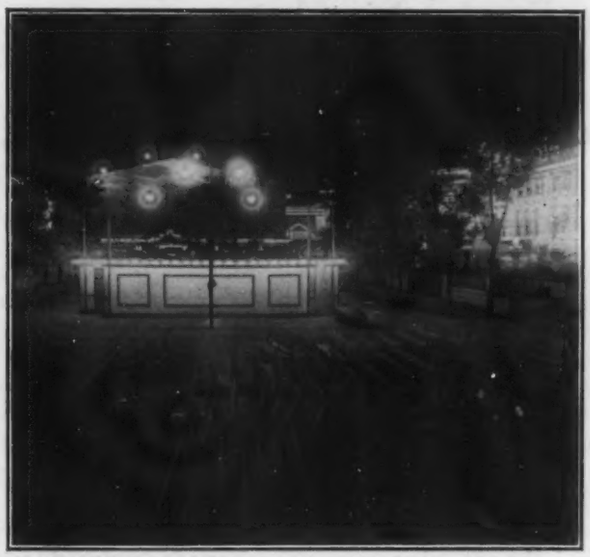
Night View, Luna Park, Coney Island, N. Y., Showing 750 Watt Mazda Lamps.

Night View of a Portion of White City Park, Chicago, Ill., Showing Application of 1000 Watt Mazda Lamps.

The amusement parks have been quick to see the advantages of these lamps, and installations are scattered throughout the country. Photographs have been taken of several of these and it is of interest to show a number. At Luna Park, Coney Island, over eighty 750 and 1000 watt Mazda lamps are used. This particular view shows thes lamps lighted alone, with the outline lighting extinguished. A ventilated weatherproof holder contains the Mogul socket and supports the diffusing globe which surrounds the lamp, thus protecting the eye. Over the main walk shown at the center, the fixtures are placed, in two rows, about 16 ft. above the ground, long wire spans being the means of suspension. At the left, around the lagoon, and at the right in front of the concessions, ornamental iron standards serve to carry the equipment. The effect is spectacular, the standard of lighting is high, and although everything is very bright, glare is not noticeable.

At White City Park, Chicago, a considerable number of high efficiency Mazda lamps for general and special lighting are used. One picture shows the tank of the "Deep Sea Divers" in the foreground, and the "Maid of the Mist" attraction in the rear. Each of these is lighted by four 1000 watt Mazda lamps in a

standard out-of-door fixture. This consists of an ornamental, ventilated casing over the socket, a heart-



Brilliant Lighting Provided by High Efficiency Mazda Lamps at White City Park, Chicago, Ill.

shaped diffusing globe, and a porcelain enamel reflector. The other view is of the "Figure Eight" ride which uses five 1000 watt Mazda lamps with the type fixture which has just been described.

CHANDELIER INSTALLATION.

BY CHARLES T. PHILLIPS.

Providing for Electric Cooking Devices.

Due to the increased use of electric cooking devices, such as percolators, tea samovars, toasters, chafing dishes, etc., on the dining table, the scheme shown here is recommended as an inexpensive means of providing for same.

The lights are controlled independently of the cooking devices.

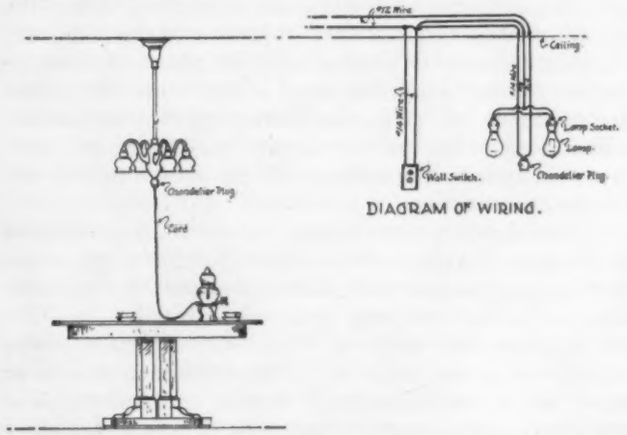


DIAGRAM OF WIRING.

Specifications call for the wiring to center outlet in dining room (and other room as required) with one circuit of No. 12 wire. Bring out three wires at outlet, one common, one from wall switch and one from ahead of wall switch.

The fixtures should have sockets for lights and one 10 ampere chandelier plug. Wire the stem of the fixture with two No. 14 and one No. 18 wire. Connect to wiring so plug will be ahead of wall switch.

ERRORS IN POWER MEASUREMENTS DUE TO INSTRUMENT TRANSFORMERS.

BY W. M. SHEPARD.

(Following an analytical discussion showing the cause and effect of errors introduced in power measurement because of current and voltage transformers, the author makes suggestions whereby they may be compensated or reduced to a minimum. Mr. Shepard is special solicitor with the San Francisco office of the General Electric Company and joint author of the "Watthour Meter."—The Editor.)

Errors introduced into wattmeter and watthour meter readings through the use of instrument transformers are of two kinds, (1) errors in ratio and (2) errors in phase angle. The magnitude of these errors will depend on the characteristics of the transformers and the amount and power factor of the load being measured and the power factor and volt ampere load on the secondaries of the instrument transformers.

In order to bring out the reasons for these errors, it is necessary to go briefly into the relations between primary and secondary currents and voltages of the current and voltage transformers.

Fig. 1 is a vector diagram of a current transformer.

O I is the line current.

O X is the exciting current.

O M is the magnetizing component and **X M** is the energy component of the exciting current.

I_p is the component of primary current which balances the current in secondary.

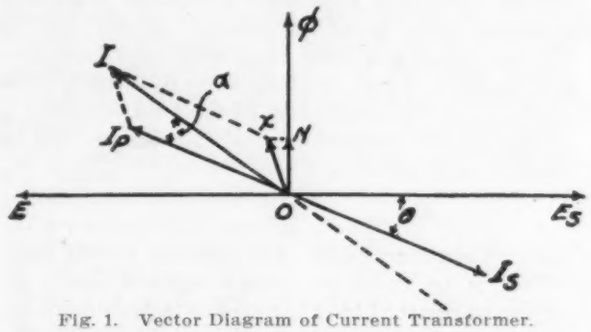


Fig. 1. Vector Diagram of Current Transformer.

I_s is secondary current and is equal to **I P** divided by **N**, where **N** is the ratio of secondary to primary turns.

$O\phi$ is magnetic flux in transformer core.

O E is voltage induced in primary.

O E_s is voltage induced in secondary.

θ is angle of phase displacement between secondary current and voltage.

Cosine **b** is power factor of secondary load.

a is phase angle of transformer; it is the angle by which the secondary current is displaced from its 180 degree relation to the primary current and is due to the exciting current taken by the transformer.

n is ratio of current transformer and equals **I** divided by I_s.

N is ratio of primary to secondary turns and equals I_p divided by I_s.

If the exciting current **O X** was zero **I P** would be equal to and in phase with **I**; a would disappear and **n** would equal **N**.

It is evident that the exciting current is responsible for the errors of the current transformer and it is therefore important that the exciting curent be kept

small if accurate results are expected from the transformer.

The exciting current of a current transformer will vary with the volt ampere load on the secondary; being larger the heavier this load, as a higher voltage will have to be induced in the windings to force the current through the higher external impedance connected in series with the secondary.

The phase angle of the current transformer depends not only on the exciting current, but also on the power factor of the volt ampere load on the transformer secondary. In other words, it depends also on the angle θ in Fig. 1. This is evident from Fig. 2.

It is seen, from Fig. 2, that at a certain value of θ the phase angle α disappears. The error in ratio, however, is a maximum at this point.

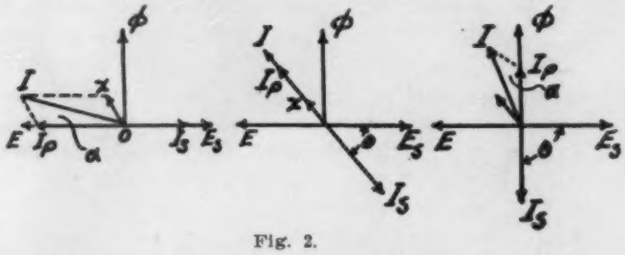


Fig. 2.

The effect of ratio error, with heavy secondary load, is to make meters connected to the secondary register low at all loads and especially at light loads.

With very light secondary loads the ratio error may be such as to make the meters register high due to the fact that the true ratio will approach more nearly the ratio of turns and the ratio of turns is somewhat less than the rated ratio of the transformer.

With current transformers of fair design, this latter error is negligible.

The effect of errors of phase angle is negligible at unity power factor, but for lagging power factor makes the meters register high. For leading power factor the effect is to make the meter register low. The power factor referred to is the power factor of the load being measured.

If current transformers are used without potential transformers, this may be a source of considerable error. The effect of the potential transformer phase angle is to counter-balance that of the current transformer and so reduce any errors from this source.

Current transformers should never have their secondary circuits opened when current is flowing in the primary. This is not only on account of the high voltage which will be induced in the secondary if a large primary current is flowing, but also because the characteristics of the transformer may be changed due to the excessive magnetizing current (line current), as if the secondary is closed or the primary circuit opened under these conditions, the core may remain in a permanently magnetized state. It will then take a higher magnetizing current under ordinary conditions and both its ratio and phase angle will be changed. If this should happen the core can be demagnetized by operating the current transformer with open secondary circuit and gradually reducing the primary current to zero, or by very gradually cutting out resistance in the secondary circuit (starting with high resistance) until it is short circuited.

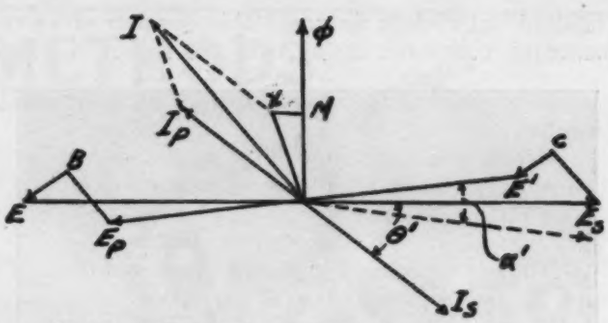


Fig. 3. Vector Diagram of Voltage Transformer.

Fig. 3 is a vector diagram of a voltage transformer.

O E is the primary terminal voltage.
O E$_p$ is the primary induced voltage.
O E$_s$ is the secondary induced voltage.
O e is the secondary terminal voltage.
O X is the magnetizing current.
O I$_s$ is the secondary current.
O I is the primary current.

α' is phase angle of transformer; it is the angle by which the secondary terminal voltage is displaced from the 180 degree position with respect to the primary terminal voltage.

n is actual ratio of transformer and equals **O E** divided by **Oe.**

N is the ratio of turns and equals **O E$_p$** divided by **O E$_s$.**

N is the ratio of turns and equals **O E P** divided by **O E S.**

B E$_p$ is primary resistance drop.
C E$_s$ is secondary resistance drop.
BE is primary reactance drop.
C E is secondary reactance drop.

Cosine θ' is power factor of the load on the secondary of the voltage transformer.

The impedance drop in the primary and secondary windings is responsible for the phase angle α'. If the resistance drop exceeds the reactance drop **O e** will lead the 180 degree position with respect to **O E.** This condition exists in standard voltage transformers and is desirable as this displacement in phase of the secondary voltage is in the same direction as the phase displacement of the secondary current transformer, when used with ordinary meter loads and so, in a measure, cancels the error from this source introduced by the current transformer.

The regulation of voltage transformers is poor due to the high resistance drop. The amount of secondary load which can be supplied from one transformer with a fair degree of accuracy is therefore small.

If the phase angle α of the current transformer equals the phase angle α' of the voltage transformer there will be no phase angle error. Ordinarily this is not the case and where a very high degree of accuracy is required in watthour meters the difference between these angles is made up in lagging the meter.

When the phase angles completely cancel each other, the watthour meter should be lagged so that the flux from the potential pole is exactly 90 degrees behind the impressed voltage in phase.

If the phase angles α and α' do not completely cancel each other the meter should be lagged so that the phase of the flux from the potential pole differs from

the 90 degrees position by an angle β such that $\beta = \alpha - \alpha'$.

The watthour meter should be lagged for $(90 - \beta)$ degrees instead of for 90 degrees flux lag as ordinarily required.

Errors due to ratio can, to a certain extent, be compensated for by adjusting the meter at unity power factor taking into consideration these errors, as shown by the ratio curve of the transformers.

The errors in ratio of the current transformer vary with the line current and to compensate for this on light load the light load adjustment of watthour meters is set to make the meter fast on light loads, as the effect of the current transformer is to make it slow at light loads.

The amount of adjustment necessary in the watthour meter will depend on the characteristics of the current and voltage transformers and the amount of load connected to the secondaries of these transformers.

The amount of adjustment should be determined from the characteristic curves of the transformers.

The first oil motor ship to be built in the West was recently completed at Seattle by Nilson & Kelez. This boat is now being used in the cannery trade, being driven by a four-cylinder, 120 h.p., four-stroke cycle Diesel engine. It is 87 ft. long, 17 ft. beam and 7 ft. draught. The dynamo, auxiliary pumps and small compressor are driven by a 12 h.p. unit and a 9 h.p. unit drives a hoist. The trial trip showed a fuel consumption of 6¼ gallons of Star oil per hour at a speed of 10.3 knots.

Infusorial earth is being mined more actively in California and Nevada, which produced nearly 90 per cent of the 6528 tons output last year in the United States. The value averaged $10.50 per ton. Heretofore diatomaceous or infusorial earth has been largely used as an abrasive in the form of polishing powders and scouring soaps, but the United States Geological Survey finds that of late its uses have been considerably extended. Because of its porous nature it has been used in the manufacture of dynamite as a holder of nitroglycerine, but so far as known not in the United States. Its porosity also renders it a nonconductor of heat, and this quality in connection with its lightness has extended its use as an insulating packing material for safes, steam pipes, and boilers, and as a fireproof building material. In this country a new use of the material is reported in the manufacture of records for talking machines. For this purpose it is boiled with shellac, and the resulting product has the necessary hardness to give good results. In Europe, especially in Germany, infusorial earth has lately found extended application. It has been used in preparing artificial fertilizers, especially in the absorption of liquid manures; in the manufacture of water glass, of various cements, of glazing for tiles, of artificial stone, of ultramarine and various pigments, of aniline and alizarine colors, of paper, sealing wax, fireworks, gutta-percha objects, Swedish matches, solidified bromine, scouring powders, papier-machie, and many other articles. There is a large and steadily growing demand for it.

LETTER TO THE EDITOR.

Criticism of Seattle Lighting Department Cost Data.

To the Editor:

J. D. Ross, superintendent of lighting, the official head of the municipal lighting plant of Seattle, Washington, has issued a biennial report for the years 1912-13 covering the operation of his department. As published in your issue of July 25th, the report sets forth in great detail general and unit costs of the plant and its component parts. These costs are in many instances very low and give the impression that the municipal lighting plant of Seattle has been constructed at a remarkably low cost. These hydroelectric costs data are, however, not founded on facts, and a study of them will disclose that the superintendent has drawn on his imagination in order to show low costs. In order that such costs shall be of any value at all, they must be based upon facts and absolutely square with the truth.

The total cost per kilowatt of the generating system is given as $82.96. The method adopted to obtain this result is quite unusual and his figures do not mean anything, although apt to deceive the taxpayer. His method of arriving at the cost per kilowatt of the generating system is to take the total cost at the end of 1912 of crib dam, penstocks, pewer station, transmission lines, city substation and Lake Union auxiliary station, and divide each one of these costs by 15,500 kw. (assumed capacity of the system), add these dividends together and obtain the figure of $82.96 per kw. The capacity of the crib dam is given at 9000 kw.; of the penstocks, 11,000 kw.; of the Cedar Falls generators, 13.500 kw., and of the Lake Union auxiliary, 1900 kw.

Now as to the capacity of the penstocks, 11,000 kw., Mr. Ross recently testified at North Yakima before the Public Service Commission of the State of Washington, "the pipes will probably fail at about 11,000 kw., even if we had all the water." He has repeatedly stated officially when urging the acquisition of additional water powers by the city that the plant was up to its capacity at 10,000 kw. As a matter of fact, the maximum output of the Cedar Falls plant at any time as shown by the load data sheets kept in the power house occurred in November, 1913, and was 10,100 kw., and the superintendent testified at a Public Service Commission investigation at North Yakima recently that the Cedar Falls plant was overloaded last winter a few times when the Lake Union auxiliary had to help out. This is the maximum that the plant is capable of generating and the proof of this is that the lighting department was compelled to purchase additional power from the Schwager-Nettleton sawmill and also run the Lake Union auxiliary over the peak load last winter when the Cedar Falls plant was operating at its maximum of 10,100 kw. The report also states that the maximum load at all generators for 1913 was 10,625 kw., and this evidently includes Cedar Falls, Lake Union auxiliary and Schwager-Nettleton plants. The rated capacity of the generators at the falls, two 1200 kw. and two 4000 kw., aggregate 10,400 kw., and this is the capacity that will be used in determining the cost per kw. of the generating system, although the limit-

ing factor in determining this cost should be the maximum output that the plant is capable of delivering—10,100 kw. It will be noted that the capacity of the 4000 kw. machines is placed at 5000 kw. each and the 1200 kw. machines at 1750 each, a total of 13,500, while later the Lake Union 1500 kw. machine is rated at 1900 kw., a total of 15,400 kw. for all, and this figure for the purpose of the superintendent's calculations has been raised to 15,500 kw.

The investment figures of the generating system for 1912 were taken to show the unit cost per kw. of the system. Why were not the 1913 investment figures used, which are somewhat greater than the 1912, inasmuch as they are given in the same report? The 1912 figures will be used to show that the superintendent's cost of $82.96 per kw. is far too low, and then the cost per kw. at the end of 1913 will be shown for the system, exclusive of the Lake Union auxiliary.

The investment in crib dam, penstocks, falls plant, transmission lines and substations as given in the report for 1912 is $1,190,448.66. To this should be added certain items, such as transmission line right of way, city substation sites, Cedar station furniture and material at Cedar Falls, amounting to $29,397.28, making a total investment of $1,219,845.94, which on the basis of 10,400 kw. rated capacity gives a unit cost of $117.29 per kw. of the generating system exclusive of the Lake Union auxiliary plant. There was an additional investment in this plant on account of the construction of the new Cedar Falls dam. The reports show that up to December 31, 1912, the sum of $618,528.65 had been expended on this new masonry dam. The dam is being erected below the crib dam, and the contract calls for a dam carried up to practically the same height as the crib dam, which will therefore add but very little to the present capacity of the plant. The cost of this dam should be taken into consideration in arriving at the cost per unit of the plant.

The cost of the Lake Union auxiliary plant is given as $6.16 per kw. based on 15,500 kw. This of course means nothing and is misleading. The rated capacity of this plant is 1500 kw. and cost $95,550.32 up to December 31, 1912, and the unit cost would therefore be $63.70. The load factor of this plant is entirely different from that of Cedar Falls, the plant being used only in emergencies and at times to carry the peak of the system. It cannot be classed as a capacity plant for the reason that the Water Department which owns the reservoir will not permit the water to be drawn from the reservoir for a longer period than two hours at a time without service, on account of depletion of water, and if the plant is to be run for any long period, two hours' notice must be given by the Lighting Department to the Water Department in order to give the water in the pipe line time to move, otherwise the pipe leading to the reservoir from Cedar River would collapse. The Lighting Department pays the Water Department one cent per kw.-hr. for all power generated at the plant and in 1913, 54,500 kw.-hr. were generated, which is the output of the plant at normal rating and 100 per cent load factor for 36 hours. Attention is here called to the fact that 45,100 kw.-hr. were purchased during the year from Schwager-Nettleton Mill Company to help out, and why this power was not generated at the Lake Union substation is not explained, unless it is that the Lake Union plant is only available in emergencies. Since the hydraulic development was made by the Water Department, and the Lighting Department installed the generating plant, the latter occupies the position of a purchaser of power. It would therefore be proper to capitalize a part of this charge of one cent per kw-hr. and get a unit cost and add this to the $63.70 per kw-hr. above obtained in order to arrive at a fair cost for the Lake Union plant, which the superintendent states cost only $6.16 per kw.

It is interesting as well as instructive to work out the cost per kw. of the Cedar Falls plant at the end of 1913, and see how this compares with the superintendent's figures for combined generating system at the end of 1912.

The investment for crib dam, penstocks, power station, transmission lines and city substations totals $1,236,454.08, and to this sum should be added certain other items, such as transmission lines, rights of way city substation sites, Cedar Falls station furniture, tow boats and materials, a total of $45,847.34, making a total investment of $1,282,301.42, which, based on the rated capacity of the plant, 10,400 kw. (the maximum ever obtained being only 10,100 kw.) gives a cost per kilowatt of $123.30.

In addition to this there had been expended on the new masonry dam up to December 31, 1913, the sum of $1,037,807.28, which, when completed to the contracted height, approximately that of the old dam will not materially increase the capacity of the plant and which adds $99.79 to the above cost of $123.30 thus making the total cost of the generating system $223.09, instead of $82.96 per kw., the reported cost of the system, including the Lake Union auxiliary, at the end of 1913. The investment in the dam, when completed to approximately the same height as the crib dam, will be $1,250,000, without materially increasing the capacity of the plant, but it will bring the cost per kilowatt of the system up to $243.49.

It is unnecessary to comment further on this costs data. The cost figures in the report in a great many cases are inaccurate and full of "the sins of omission and commission," and cannot, as the superintendent states in his preface, make the report "a valuable reference volume."

Aug. 1, 1914. SUBSCRIBER.

An "appropriator" of water, as defined by the Supreme Court of Nevada and reported in the Reclamation Record, is one who obtains water for irrigation from a water company diverting water from a stream into an artificial waterway for sale within the rule that a prior appropriation is a prior right and the company is but his agent, and the right of user is equivalent to an easement in the artificial way of the company to the extent of the amount of water delivered by the company, which right is contingent only on the acts of the actual appropriator in paying a reasonable compensation for the water obtained. It was also held that the right of an actual appropriator of water for beneficial use is a part of the freehold whether it is obtained by diverting it from a natural course or by purchase from a water company.

RESUME OF DIESEL ENGINE INSTALLATIONS.

(Discussion by San Francisco Section of the American Institute of Electrical Engineers, on paper by L. R. Jorgensen printed in this journal May 23, 1914.—The Editor.)

W. M. Smith:—I would like to ask Mr. Jorgensen whether the records that have been given in his paper are based on mineral oil as fuel, that is, crude oil or petroleum that is treated in some way? Also is it not a fact that the Diesel engine is supposed to be suitable for burning almost any kind of (I was going to say refuse) very low grade liquid fuel? I have understood that coal tar and such compounds were suitable for use in a Diesel engine, and I have had the impression refuse which was really not suitable for any other use, or not suitable as fuel in any other way, was suitable for this work in a Diesel engine.

L. R. Jorgensen:—A large Diesel motor, especially if it has a slow piston speed, can use an oil containing a large percentage of asphalt; but a small engine, where the valve openings are necessarily small, will require better oil. The engines can even use crude oil from which the gasoline has been taken. The "Siam" took some oil on board in San Pedro which was too thick; it worked fairly well from San Pedro to San Francisco; but they were not going to take a chance on it after they left San Francisco because the ship was afterward to sail in colder water, and the oil was already so thick that the feed pump had to raise the pressure up to 85 atmospheres in order to squeeze it through the valve openings. If the oil is so thick that the feed pump would have to raise the pressure up to 100 atmospheres, the safety valve would open up, and no oil would enter the cylinders. The Diesel engines can readily use any oil where the asphaltum is not over 25 per cent. Of course you cannot use Diesel engines everywhere, because you cannot get oil everywhere; but between this coast and Europe any ship can use Diesel engines to advantage. But on vessels running between the continent and English ports it would not pay to install Diesel engines, because oil is so much higher than coal in England.

A. H. Babcock:—I think Mr. Jorgensen has drawn the picture very mildly of the ease and simplicity of handling the engine room of the "Siam." It was entirely to short for most of us. We would have been glad to have made a much longer voyage. The engines are almost unbelievably prompt in response to bridge signals; and further than that, there is none of the preliminary slow movement in reversal or starting that we are accustomed to see in the steam engine. There is a positive air pressure of 20 atmospheres, if I remember correctly, back of the starting valve; and the consequence is that within a turn, or two turns at the most, your screws are going practically at full speed. I think it would be very easy to get too high torque on the first few strokes, and to go past the decavitation point. In fact, as I remember the handling of the engine, it was necessary to notch the starting lever back very quickly after the first explosion occurred in order to prevent the racing of the engine. It is very difficult to speak without over enthusiasm on the impressions of that trip. The engine room was so quiet—I mean by that, that there was no running around; all the gear was within easy reach. One of the most impressive features of the trip was the exceedingly prompt reversal from full or half speed ahead on one engine and full ahead on the other, to both full astern in a very few seconds.

There is one point of view in connection with the paper I would like to emphasize a little: I think the speaker has been too modest about it. He knows a good deal more about Diesel engines than he has told us; and for that reason he presented the adverse side as well as the favorable side. The paper has taken into account more of the general view of the subject than we are accustomed to see. In the last meeting of the Mechanical Engineers it did not seem to me that all the facts were brought out, and I stated so in discussion that night. That paper followed a very common tendency of the enthusiast—to speak of one side of the subject, and to overlook the things that count against it; whereas all engineers are concerned with the sum total of the work, which, as I have said many times, is shown by the auditor's balance sheet.

There are places where the Diesel motor is clearly not the proper prime mover. On the other hand, there are places where it is clearly the best thing to put in. My personal feeling is that the Diesel will become a serious factor in our every day life for installations where the load factor is reasonably high, say from .6 to .8. In other words, the nearer you approach to ship practice the more economical will be the use of the Diesel motor. On the other hand, I cannot imagine putting a turbine into such a ship as the "Siam" any more than I can imagine putting a Diesel engine into such a power house as drives one of our railroads. The two are utterly unthinkable from the engineering standpoint. The one is concerned with a very nearly constant load, in which the Diesel is certainly to be reckoned with; and the other is concerned with an extremely fluctuating load, where, if the first costs, and consequently the fixed charges, are to be kept within reason, the cost of installation must be kept down. And there must be large over-load capacity. Take, for instance, the steam turbines in one of our large railway stations; it is not at all uncommon to see a machine loaded up to 200 per cent momentarily, sometimes 250 per cent, and almost while you are wondering what is going to happen the load drops off to may be one-quarter full load. I cannot imagine a Diesel operating with any economy, with any sat isfaction, under such conditions, whereas the steam turbine does very well.

So I would add emphasis to what the speaker has said; that it is quite necessary not to be led away by enthusiasm over a high thermal efficiency to the point where one will overlook the other features. For example, cost of lubrication (which for small units is very high comparatively speaking) and the fixed charges that always have to be reckoned with.

I would emphasize again the point that it is refreshing to listen to a paper that does take into account both sides of a very important question.

L. R. Jorgenson.—A Diesel motor could be used to advantage in a central station (if the engines could be built large enough) where the motor could run for 24 hours on full load, and the steam turbine could take the rest of the load, so that the Diesel motor utilized its full economy during 24 hours. The hot gases, if exhausted under the boilers, could keep several boilers hot, so that if anything happened to the transmission line, the boilers would be ready to deliver steam to the turbines.

The Diesel motor is very much in the same fix as a water power plant. It seldom pays to build a water power plant if you haven't a good load factor for it; but it pays to have in combination with it a steam turbine, because the steam turbine is the most economical device known to take care of the load fluctuations.

The great advantages that a two-cycle motor has over a four-cycle motor are its cheapness, its smaller weight and less floor space required. In a ship of large size this last item does not count, as, according to the rules in force for measuring ships, the power plant must take up at least 13 per cent of the total cubic contents of the ship.

It is an international agreement that 32 per cent of the volume of a ship is subtracted in measuring up for harbor taxation and canal toll purposes in case the machinery occupies at least 13 per cent of the total space; if it occu-

pies less, however, nothing is subtracted. A four-cycle motor can generally be put inside this 13 per cent limit; and nothing would be gained by having much idle space in the engine room, and to make the engine room smaller than the 13 per cent limit would only cut down the earning power of the boat.

Of course this does not hold true in the case of a war vessel, where much power must be produced with a given weight of machinery in the smallest possible space.

Mr. Howell:—As Mr. Jorgensen and Mr. Babcock have stated I agree that the Diesel engine should only be used where you have a good load factor. For instance, in Sherman, Texas, the load factor of the lighting plant is only 29 per cent. The best that they can do is to produce electricity at a cost of .68 of a cent per kw.-hr. This cost includes the lubricating oil, fuel oil, cooling water and cleaning material, average repairs for two years and labor, but does not take into account depreciation, taxes, etc. The plant is equipped with three 225 h.p Diesel engines, two of them are running most of the time, one occasionally on the light loads, and sometimes three.

As regards the consumption of lubricating oil, I might say that it is rather high with small engines of 100 h.p., but with an engine of 225 h.p., the guarantee consumption for lubrication is eight quarts for 5400 b.h.p., or about 1.8 grams per b.h.p.

In reply to the request of Mr. Jorgensen regarding Diesel engines in submarines, the United States Government adopted in 1909 the 4-cycle Nuremberg engine because the Otto gasoline engine formerly used was dangerous. The gasoline exposed through the carburetor into the boat, caused explosions, none of which were fatal to the boat, but which caused many casualties.

A great many troubles were encountered with the air compressor on these 4-cycle Diesel engines, because the compressor had to furnish a large volume of air, and was driven directly off of the crankshaft. The lubricating oil consumption was rather high; (about ten gallons per 100 b.h.p. for a 24 hour run or 80 gallons for 800 b.h.p. for 24 hours running.) This was due to the high speed.

The submarine is provided with a generator which may be used as a motor or a generator alternately, the Diesel engine drives this generator to recharge the storage batteries. The backlash of the 4-cylinder, 4-cycle engine caused the risers from the armature of the generator to drop. The United States Government then adopted a six-cylinder, 4-cycle engine of 500 b.h.p., 420 revolutions, with a little better designed air compressor, and they did not have as much trouble with the engine as far as the electrical equipment was concerned, but they did have trouble with the valve mechanism and the air compressor. However, the boats that were recently built at the Union Iron Works went to San Diego without mishap. The engines weighed 200 pounds per b.h.p.

The Nuremberg people and the Sulzer people have developed 2-cycle engines. The Sulzer engine has a separate scavenging cylinder, which with the six cylinders, makes a seven-cylinder engine. The Nuremberg engine has a step piston, the larger piston being below the working pistons, to carry a pressure of 5 lb., above atmosphere to scavenge the cylinders. The air compressor is mounted on one end, (lately built with the different stages mounted radially). These compressors are not in general use however, (due to the high cost). The 2-cycle engine weighs about 88 lb. per b.h.p., the latest one built for the Italian navy, weighed 44 lb. per b.h.p., the space occupied by them is about one-half that occupied by 4-cycle engines for the same h.p.

The power of these engines has increased to 1250 h.p., for the new submarine boats, and they are now building engines which will develop 1800 h.p. Engines of 8 cylinders each, originally designed for 800 h.p., when put on the test block gave considerably over 1250 h.p., showing that they are capable of a big overload capacity, though not as great as turbines. The mean effective pressure in the engines of submarines is 117 lb., instead of 110 lb., as in the ordinary stationary Diesel type of engine. All of the submarines in Europe are equipped with 2-cycle Diesel engines, the 4-cycle having been superseded.

According to Lloyd's rules, if you save space, with a Diesel engine installation, you are not allowed to use all for cargo, but must keep part for future machinery installations if deemed necessary.

As regards the marine Diesel engine we must obtain the proper propeller speed. The engine room space will enable you to have separate air compressors. In the "Siam" or ships of its class, they have two air compressors. If one breaks down it does not necessarily tie up one of your engines. With the submarine, however, if anything happens to one of the air compressors, as it is on the same shaft with the engine, then that engine is out of commission until the air compressor is repaired.

It is generally known that when using a mechanical atomizer, you must first prepare the oil, take out the grit and dirt and heat it so it will flow, and it must contain approximately 18,000 B.t.u. A Diesel engine can burn any oil that can be burned underneath the boiler, provided the same treatment is given to the oil that would be required to burn it under the boiler. In Germany they burn coal tar, by preheating. They also burn earth nut oil in Africa. This oil contains about 14,000 B.t.u. per pound.

I now will explain why the fuel oil taken on board the "Siam" at San Pedro, was discharged at this port. The "Siam's" fuel pumps were built for a working pressure not exceeding 65 atmospheres. When this vessel arrived in San Francisco, they called upon me in a consulting capacity, as regards their oil.

The chief engineer of the "Siam" stated that with the San Pedro fuel oil that the pressure (due to viscosity), and asphaltum content 55 per cent, exceeded 65 atmospheres. He feared that the pumps would probably break when they got into a colder climate, and as they were going to Vladivostok, and were not equipped with heating coils, they changed from San Pedro fuel oil to Star fuel oil. The "Siam" recently reached Hongkong, and had absolutely no trouble with the engines from the time she left that port until her return. The fuel oil economy was bettered 10 per cent with the Star fuel oil, as compared to Borneo fuel oil, which she originally operated upon.

In California, the best oil to use for continuous use, running the engine 300 days a year, would be a little better grade of oil than crude oil; the Standard Oil Company put out what is commonly called Star fuel oil, a standard grade of oil with 25 per cent asphaltum, perfectly clean, and free from foreign impurities.

Guy Bailey:—It seems to me, one thing has been overlooked of some interest to power plant engineers, and that is that the Diesel engine in small sizes has an efficiency comparable to the larger sized units. I think that is a characteristic that is not shared by other forms of prime movers. In small isolated plants in particular that may be a decided advantage. I would like to have Mr. Jorgensen say something about that.

L. R. Jorgensen:—That is a fact; and that is also the reason why the Diesel motor is a success in small isolated plants, and not in large central stations yet. One thing must not be forgotten, that they cost twice as much as an ordinary steam engine installation. A Diesel motor of, say 200 h.p. size, costs about $60 a horsepower.

The calculation of the profit to be gained by using a motor on a ship instead of a steam engine will in the case of the ship "Selandia" look about as follows: The engines of the "Selandia" cost about $19.50 per h.p. more than a

steam plant would have cost, or a total of $48,600 more for the same displacement. To pay for this there is 1000 tons more freight on three voyages per year Copenhagen-Siam, or a total of 6000 tons at $4.86, or a total of $29,160. A ship like the "Selandia" will save at least $24,300 worth of fuel per year; and if we figure only 500 tons of extra freight per trip, the total savings per year will be $38,880. The engine room force in the "Selandia" consists of three engineers, four assistants and two oilers. A single screw steamship of the same size would have three engineers, three assistants and 10 firemen (coal). There is therefore a still further saving in the motor boat in the labor expense. The fuel-oil tanks can be completely filled in eight to ten hours with a minimum amount of labor, and the twelve hoists on deck are electrically driven with the motors acting as generators when load is going down, all with a view towards economy.

W. H. Smith:—I would like to know if Mr. Jorgensen has any figures on the cost of stationary plants. We know, for instance, on a first-class steam turbine power plant it will run around two pounds of coal per kw.-hr. on a large public utility, say, anywhere between 24,000 to 28,000 B.t.u. per kw.-hr. generated. Now are there any figures available on the basis of using fuel oil at some different figure than say 19,000 B.t.u. per pound? What is the net result with a Diesel motor?

L. R. Jorgensen:—Here on the Coast are two or three firms I believe that make smaller Diesel motors, and any of those firms will guarantee the fuel consumption for those small engines of .45 lb. per brake h.p. I do not think it pays to make a smaller Diesel motor than say 50 h.p., but that would be a safe guarantee if they can make the engine at all —less than half a pound of oil per brake h.p. It is true that the economy is not so very much different in a small engine and a large engine, although in a large engine the fuel consumption should come down to .36 lb. of oil per brake h.p. I should say that a 50 h.p. engine has probably twice as high an economy as a 5000 h.p. steam turbine.

R. B. Scott:—I have had a little experience with Diesel engines using California oil. It is as good a fuel as you can put into a Diesel, provided it is treated in the right manner and the engine is in good condition. You can get an engine to clog up on kerosene if you want to. If the engine is not adjusted properly, valves leaking, or you are not getting the proper air pressure, you can soot up your valves as well as you can with California crude oil; but if the engine is in proper working condition, and your fuel injection is work-as it should be, your valves are all tight, the California crude oil or Star fuel oil is as good a fuel as you can put in a Diesel engine.

I had the first California oil sent home to the old country about three years ago, and tested an engine out on it; the oil then was said to be as good a fuel as you could wish for the Diesel engine. Since then I have made tests with crude oil 16 degrees gravity in the Diesel engine and there is no question the engine will run on it; but if you are to run steadily on this oil, and your load is going to fluctuate, you must heat the oil so that the governor will cut off quick enough, so that you get the quantity of fuel delivered into the cylinder to suit the load on the engine. The difficulty is that the action of the governor will lift the suction valve of the fuel pump, by passing the oil to suit the load on the engine, and the heavy oil will not pass quickly enough through the fine opening between valve and seat. The oil I used was 16 degrees gravity oil with 70 per cent asphaltum and just like molasses. It took a day and a half to fill the 100 gallon drum with a two foot fall from the tank through a one inch pipe. The engine ran on this oil for a week; but had the oil been heated it would have been much better. The only danger was that when your engine was running light or had not load enough, the governor would not be cutting off the oil, and the engine would not be burning it, so the oil going into the cylinders would clog up the valves and pistons. There is of course the question of climate. You take this oil here on a cold morning you cannot get it to move, but by noon the pipes are warm and it runs all right.

The Standard Oil Company's Star fuel was 19,000 B.t.u. and 24 degrees Baume, 25 per cent asphaltum, and is a better fuel than I used in the engines in Pahang, which was Borneo oil 18,500 B.t.u., 24 degrees Baume, and petroleum base. Roughly speaking, we used in the engines in Pahang, which were rated 200 b.h.p., 200 imperial gallons per day of 24 hours, seven days per week right along, with Chinese looking after the engines. You can take the cost of California oil at one dollar per barrel, and figure it up roughly at one imperial gallon or 9.5 lb. per day of 24 hours per brake h.p. On one occasion I put in a 45 b.h.p. Diesel engine to supersede a steam pumping plant. I had oil fuel under a Babcock boiler, and two Knowles Duplex steam pumps, the plant delivering 2½ tons of water per minute, 100 ft. head, to supply the stamp battery and mill. The average fuel consumption was from 650 to 700 gallons daily. The Diesel engine drove by belt and clutch a three-throw geared pump delivering three tons of water per minute; the average fuel consumption was 37½ gallons per day. This engine and plant has been running for the last eight and a half years. In the four years the plant was under my charge the cost of repairs, that is, renewals of any part, did not cost five dollars Mex., $2.50 gold. Of course the valves had to be cleaned and ground in at stated times, which is classed as care of the engine, and is generally done by the engineer when the engine is running, spares being kept ready at all times. So far as actual repairs on the Diesel engine are concerned, with proper care they need far less than the steam plant of equal size. I have put up and have had the care of both steam and Diesel plants, and can quite appreciate the difference between them in regard to repairs. In a steam plant over and above renewals occasionally required, you have all the joining and packing both for engine and boiler, that has to be renewed all the time. On the Diesel the joints are all metal to metal, and when a good job at the start, that finishes it. You cannot have a leak on the Diesel engine, as at the high pressure you are working you are going to cut the faces, and in a few hours it will be absolutely useless. The Diesel in regard to repairs is a long way ahead of the steam plant.

In regard to central station work, I may tell you that in Hongkong they have Diesel engines that superseded steam. The steam plant was Billis & Morecomb engines and generators, B. & W. boilers, with oil fuel. They put in a 300 b.h.p. Sulzer Diesel engine and generator to run the day load, and it helped the steam plant to handle the peak load at night. The Diesel ran for 24 hours for less than it took to bank the fires under the boilers. They installed another 500 b.h.p. Diesel as a stand-by, and the steam plant was for sale. This was four years ago. In some cases there is no question but what the Diesel engine is suitable for central station work. The trouble is in the initial cost; when you get to sizes of 5000 b.h.p. and over the slow speed of the Diesel causes the cost of the generator to be high compared to one of the same power for high speed steam turbines—this along with the flexibility of the steam turbine in taking care of heavy momentary overloads. It is not that the Diesel engine is not more economical than the steam turbine or reciprocating engine at all loads, but the difference in initial cost. As Diesel engines are developed and become more general in use, this may even itself up. The outfit with the Diesel will give you the b.h.p. for far less than the steam plant. I have made 571 kw. on the switchboard to the barrel of oil with a 150 b.h.p. engine with California oil.

In regard to tar as fuel for the Diesel engine, I know of a case where the refuse tar from the Paris gas works is used in Diesel engines supplying light and power. I have this information from Mr. Chas. Day, managing director of Mirrlees, Bickerton & Day, Ltd., Stockport, England, large Diesel engine builders.

JOURNAL OF ELECTRICITY
POWER AND GAS

FOUNDED 1887

PUBLISHED WEEKLY BY THE

Technical Publishing Company

Crossley Building, San Francisco

E. B. STRONG, President and General Manager
A. H. HALLORAN, V. P. and Managing Editor
ROBT. SIBLEY, Treas. and Special Contributor
C. L. CORY, Secretary and Special Contributor
A. M. HUNT, Director and Special Contributor

ON LIBRARY CARS OF ALL SOUTHERN PACIFIC TRAINS

TERMS OF SUBSCRIPTION.

United States, Cuba and Mexico	per year,	$2.50
Dominion of Canada	" "	3.50
Other Foreign Countries within the Postal Union	" "	5.00
Single Copies, Current Month	each	.25

NOTICE TO ADVERTISERS.

Change of advertising copy should reach this office ten days in advance of date of issue. New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

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Diesel Engine Marine Possibilities

Comparisons may be odious, but they often form the basis of intelligent action in the world of trade and commerce. A discussion in this issue describes the successful application of the Diesel engine, giving especial emphasis to its value for marine propulsion.

It is unnecessary to now delve further into the economies and the other advantages of this method of propulsion or to here note the limitations of present types of Diesel engines, which limitations themselves dangle opportunity before the inventive mind.

It might, however, be of service to glance into the past in order that we may with more encouragement look forward into the future. The clock that ticks the centuries has swung far over, the escapement has resounded and the return journey of the pendulum has commenced since the first power-propelled ships were used for commercial purposes. At that time a feature ship advertised by one company was described as "a handsome and stout steam vessel, having two engines of the power of twenty horses each, with two copper boilers, and having safety valves and everything of the most approved principles," and so forth.

The century since escaped has left to the world a steamship tonnage legacy of over forty-five millions, and the "two engines of the power of twenty horses" are insignificant compared even with the horse power of engines of present-day motor ships—the latest nurslings of the sea, created at the dawn of what may prove a new era in marine propulsion—though even the largest of these is in turn insignificant compared with the engines of the leviathan liners now necessary for trans-Atlantic service.

And that the tonnage growth of steamships has been accompanied by a still more remarkable growth in the efficiency of marine engines points to the enormous possibilities contained in further improvements in oil motors.

There is apparently no saturation point in power boat development—the word "power" being here used to cover the entire range of mechanically propelled ships—for during the past year an increase of over two million tons was registered throughout the world; a remarkable expansion over so short a period.

In 1883, the year usually understood to be that of the starting of the new United States navy, the amount appropriated for this purpose was less than fifteen million dollars, while for 1913 it was one hundred and forty million dollars. It is more than probable that this amount will continually increase.

On the Pacific Coast growing interest is with the opening of the Panama Canal, being manifested in shipbuilding; the realized need for the more rapid development of Pacific Coast industries being an added stimulus.

The extensive use of the Diesel engine here is practically certain, and this will aid California in unloading her burden of oil.

To the young man and to the man of older years, though young in purpose, this field is shown, through these comparisons, to offer untold prospects and opportunities. It is a claim worth filing on and cultivating.

Service Connections

A utility distributing system, like the proverbial work of a woman, is never completed. Each group of new consumers calls for extensions which must be financed, often a matter of great difficulty. The moot question as to who shall pay for service connections, the company or the consumer, has finally been decided in California by the State Supreme Court in favor of the consumer, the company being required to pay the cost.

The Miradero Water Company had questioned the right of the State Railroad Commission to order that water connection and meters be furnished without charge to the people of Glendale, a city which had not yet elected to surrender its power over public utilities to the commission.

The court holds that the commission has the right to make the order but that its enforcement rests with the municipality. It furthermore holds that under its franchise provisions the water company has not performed its full duty until service pipes have been laid to the consumer's premises. This ruling is equally applicable to telephone, gas and electric companies and definitely clarifies a situation that has long been a bone of contention.

It must not be thought, however, that service connection means service extension. While the California Commission has already gone on record as not approving the practice of refusing to make an extension unless the proposed customer pays for it, the U. S. Supreme Court has ruled that unprofitable service extensions virtually amount to unlawful taking of the company's property for the private use of another and that municipalities have no power to require such extensions. The Wisconsin Railroad Commission has also ruled that compulsory service extension is subject to the limitation that there shall be a reasonable expectation that the consumption will warrant the necessary preliminary expense.

The question which seems to remain for decision, consequently, is when is a connection not an extension. It may be the answer is bidden in the word "reasonable."

Eight Hour Labor Law

The powers of the initiative have been invoked to put on the ballot for the next general election in California a measure providing for universal eight hour labor in the State. Such wide-spread opposition has already been developed against this proposal that there is little likelihood of it becoming a law. Nevertheless we deem it our duty to call the attention of the engineers to its vicious features.

The law reads as follows:

Any employer who shall require or permit, or who shall suffer or permit any overseer, superintendent, foreman or other agent of such employer to require or permit any person in his employ to work more than eight hours in one day, or more than forty-eight hours in one week, except in case of extraordinary emergency, caused by fire, flood or danger to life or property, shall be guilty of a misdemeanor, and upon conviction thereof shall be fined not less than Fifty ($50) Dollars nor more than Five Hundred ($500) Dollars, or imprisonment in the county jail not less than ten (10) nor more than ninety (90) days, or both so fined and imprisoned.

The first effect of such a law would be to limit production, particularly in those industries of a seasonal character, such as agriculture, where intensive work is necessary for brief periods in order to save perishable products.

Its provisions apply to the home as well as the factory and practically prohibits domestic help for families with limited means. The absurdity of its provision, when carried to this logical extreme, is self-evident.

But the most important matter for consideration is that this proposal discriminates against one state in favor of others where such limitations are not put on industry. Its enactment would represent business suicide.

Safety First

Closely allied to industrial betterment and workers' welfare is the matter of providing safety devices. Danger divides attention, and thus diverts energy. All other factors in production should be subordinated to safety. While this has been practiced for every twenty years in Germany it is only within the past few years that public utilities, particularly electric railways, have recognized its importance.

"Safety First" is now the slogan literally "the army cry," under which a multitude of public utility employees are working. Prevention of accidents has thus become an integral part of service and the day is not far distant when there will be a national board of accident underwriters whose duties will be directed along parallel channels to those of the National Board of Fire Underwriters. All machinery, such as electrical apparatus, will be subject to inspection, as likewise will all buildings.

Most accidents are due to heedlessness. Constant contact with danger results in its being ignored. The mind becomes calloused to danger. Safety appliances are useless unless the mind is also alert.

The campaign for accident prevention is started with those most directly concerned. Employees are taught lessons in caution by means of lectures, demonstrations and literature; "safety committees" are being established, and as a result there will not only be fewer accidents, but also an increased interest in the care and upkeep of the plant.

Similarly the public should be taught to exercise care. School children are being educated in the principles of safety, public meetings are being addressed by safety engineers, moving pictures are being used to reach those otherwise inaccessible, and every effort is being made to get public co-operation in concentrating their mind on possible danger.

Such prevention of accidents will do more to solve the problem of claims for damage than all the methods of adjustment and all the employer's liability legislation which human ingenuity can devise. Since this movement was started by the electric company in Seattle four years ago the cost of accidents have been reduced one-half. Instead of spending 10 per cent of the gross railway receipts to meet damage claims, this amount has been reduced to less than five per cent. The plants in which safety first has been applied show greater profits.

But far above these mercenary considerations this movement for safety first has a deeper-lying significance in its recognition of the interest of humanity and its conservation.

PERSONALS

H. A. Kluegel, engineer for the Yosemite Power Company, is at San Francisco.

Seton Porter, member of the firm of Sanderson & Porter, is at San Francisco from New York.

A. J. Myers, Pacific Coast manager for the Wagner Electric Manufacturing Company, is at Los Angeles.

J. G. Loveday, an electrical contractor at Santa Barbara, Cal., was at San Francisco during the past week.

Prof. J. G. Lister, lecturer, B. C. E. R. Technical School at Vancouver, B. C., is spending a vacation at Butte Inlet.

J. C. Rendler, president of the Southern California Electric Company, Los Angeles, was a visitor in San Francisco this week.

A. E. Griswold, president of the A. G. Electric Company, Seattle and San Francisco, arrived in the latter city the first of the week.

C. M. Brewer, manager Western States Gas and Electric Company, Richmond, Cal., was a visitor to San Francisco during the week.

G. A. Schneider, sales engineer of the Western Electric Company, San Francisco, left for a several days' trip through the Tahoe region.

Mort K. Dodge, district manager at Seattle, Wash., for the Standard Electric Time Company, visited Vancouver, B. C., during the past week.

Carl Simmons, railway engineer of the Westinghouse Electric & Manufacturing Company, is making an inspection trip along the Pacific Coast.

H. V. Carter, president of Pacific States Electric Company, San Francisco, returned to San Francisco after an extended stay in Southern California.

W. S. Berry, sales manager of the Western Electric Company, San Francisco, returned the first part of the week from an extended trip through Mendocino county.

James W. Stokes, formerly line foreman for the San Joaquin Light & Power Company, has succeeded **Ralph Bearden,** who recently resigned as agent at Corcoran.

E. C. McBrerty, representative of the American Electric Heating Company, Detroit, Mich., is expected in San Francisco in the near future on a trip of the Pacific Coast.

Harry H. Hornsby has resigned as conduit and supply sales manager of the Sprague Electric Works, at New York City. He will announce his future plans in the autumn.

L. W. Prichett, manager of the new business department of the El Paso Electric Railway Company, is traveling through California on a month's vacation and visiting his parents at Santa Barbara.

B. R. Ellis has been appointed vice-president and purchasing agent of the Williams Water & Electric Company, which has superseded the Grand Canyon Electric Light & Power Company at Williams, Ariz.

N. E. Maddox has resigned as fixture specialist by the Inter-Mountain Electric Company of Salt Lake City to accept a position in a similar capacity for L. A. Hufschmidt Manufacturing Company of San Francisco.

H. E. Lichenstadt, manager Titan Electric Supply Company, Ltd., of Trigete, Austria, is visiting cities in the Pacific Northwest investigating the possibilities of securing the electric lamp business of the various central stations and jobbers.

W. M. Hitt has resigned as electrical engineer with the Public Service Commission of Washington to accept a position with Henry I. Lea, consulting gas engineer of Chicago, who is at present making a valuation of the Seattle Lighting Company.

E. C. Andrews, Sunbeam Lamp specialist of the Western Electric Company at Los Angeles, spent a few days in San Francisco during the week en route home from Cleveland, Ohio. While there, Mr. Andrews was an attendant at the fourth annual convention of lamp specialists.

Sidney Marshall is president and manager of the Monroe Water Company of Seattle, which has taken over the plant and franchise of the Monroe Water & Light Company, Monroe, Wash. It is stated that considerable extensions and improvements are contemplated by the new company.

M. H. Crawford, formerly engineer for the Kuhn interests and recently associated with the bond firm of Kuhn, Hill & Company at San Francisco, has been appointed commercial manager for the Bakersfield district of the San Joaquin Light & Power Company to succeed **H. A. Jastro,** who recently resigned.

E. F. Stone, superintendent of lighting and power for The Arkansas Valley Railway, Light and Power Company at Pueblo, Colo., is president of the Manufacturers' Bureau of the Pueblo Commerce Club, an organization which is carrying on an active campaign to establish new manufacturing plants at Pueblo.

T. E. Collins, division manager of the Westinghouse Electric & Manufacturing Company at San Francisco, called together a representative meeting of about fifty members of the electrical fraternity at a local cafe on August 3, to learn their opoinion as to the desirability of establishing a social club. The proposal met with great favor and various committees are now at work to report at a later meeting.

C. C. Cline, engineer British Columbia Hydrostatic Survey, is taking levels and setting up gauges on the Sumallo and Nicaloon Rivers with a view to making a report on the work in connection with the proposed water power development of the Canadian Northern. **G. Jemsen,** engineer of the railroad company, is also in the field. This activity is due to the fact that the United States authorities have withdrawn the objections to the proposed development which were based on the probability that the operations would dangerously lower the Skagit River which crosses the boundary and is therefore subject to international consideration. The 50,000 h.p. developed will be transmitted to Port Mann to be there distributed for the operation of the company's system from that point to the False Creek terminal at Vancouver, B. C.

TRADE NOTES.

The Western Electric Company has awarded the contract for the construction of a six-story re-inforced concrete building at Eighth and Santee street.

Otto B. Goldman has received the contract to furnish and install one deep well type pump direct connected to a 15 h.p. phase-wound Westinghouse motor at Lafayette, Oregon.

Frank A. Stevens Company of Los Angeles, California, sales agents for Simplex crude oil burners, have opened a salesroom at 1105 Mission street, in charge of L. F. Halloran.

Newberry-Bendheim Electrical Company has opened an electrical equipment shop at 724 South Olive street, Los Angeles. A stock of supplies and appliances is to be carried for the retail trade, contractors and consumers.

The Allis-Chalmers Company, San Francisco, has recently sold 31 motors to the Hollenbeck-Busch Planing Mill Company, a complete hydroelectric plant, including a 500 h.p. impulse wheel and alternating current generator and motors to the Engel-Cooper Company, and an 800 h.p. motor to the Pacific Coast Steel Company.

OUTLET BOXES AND PLATES IN KNOB AND TUBE CONSTRUCTION.

James M. Barry, chief of the San Francisco Department of Electricity, has ruled that in knob and tube construction, code standard outlet boxes must be installed at all outlets, except that, when it is necessary to cut an existing finished surface to set such a box flush with said surface, approved outlet plates will be accepted in lieu thereof. In any case substantial backing must be provided.

INDUSTRIAL

BENJAMIN SOCKETS FOR TYPE "C" MAZDA LAMPS.

As a part of the new line of fixtures for the new "gas filled" (Type "C") Mazda lamps the Benjamin Electric Manufacturing Company has placed upon the market two new mogul base sockets. They are two-piece porcelain sockets with means for attaching to a flange or surface. The base portion carries the binding terminals. The latter are easily accessible for wiring. One illustration shows the type where the wires are brought in through side outlets in the upper portion; in the other through the central opening. The lower portion is provided with socket shell and bronze spring

Benjamin Mogul Base Sockets.

center contact. It can be used interchangeably with either base, and is attached by two screws which form electrical connections as well as furnish means of support.

Among the characteristic features of the Benjamin line of fixtures are their patent lamp grip, which prevents loosening and falling of the lamp, the provision for ventilation for protection against rain or snow, and the fact that the weight of the fixture proper is supported by the stem rather than the socket. A new two-color bulletin has just been issued covering this complete line of devices.

OVERLOAD RELAYS.

Continuity of service is an essential consideration in all installations, and interruptions of the service cannot be tolerated unless the protection of the apparatus demands it. When they do occur they must be confined to the smallest area possible. The time element features of the Westinghouse overload relay facilitate this.

Two forms of overload relay are supplied. Both have an inverse time element as shown in Fig. 1. In one of the forms

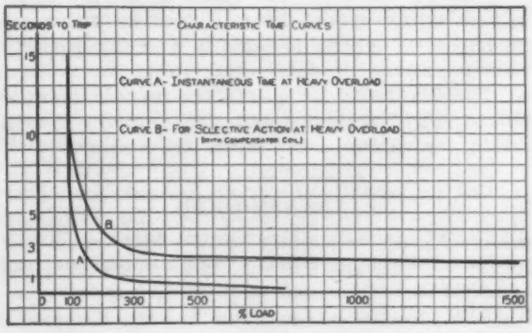

Fig. 1. Time Curves of Overload Relays.

(Curve A) which has been on the market for some time, the relay trips instantaneously at extreme overloads. In the new form (Curve B) there is an adjustable definite minimum time element. This definite minimum can be adjusted for any point from 0 to 2 seconds in the standard relays, and special relays can be supplied giving up to 10 seconds minimum.

The definite minimum time element relay provides a selective action where substations are placed in series at intervals along a transmission line, clearing the circuit at the last substation between the trouble and the generating station. Thus, suppose a generating station A, Fig. 2, with

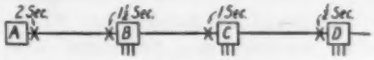

Fig. 2.

relays set for two seconds minimum, and substations B, C and D in series, with relays set for 1½, 1 and ½ second minimum respectively. If ground or short circuit occurs beyond D, relay at D cuts off the trouble section before the others operate so that the rest of the line remains in operation; if trouble occurs between C and D, relay at C will cut off the trouble; and so on.

Another use of the definite minimum time element, relay is in relieving circuit breakers. It is well known that the ultimate breaking capacity of a circuit breaker depends on the time of breaking. If a ground or short circuit can persist for two seconds before the circuit is opened, the ultimate breaking capacity is doubled, that is, the strain on the breaker is reduced to half, owing to the drop in voltage and current occurring during the interval.

This overload relay is manufactured by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

PUBLICATIONS RECEIVED.

Notes on Depreciation of National Gas Wells. Compiled by Samuel S. Wyer, Columbus, Ohio; 31 pp., 7x10 in.

"Acoustics of Auditoriums," by F. R. Watson. Bulletin No. 73, Engineering Experiment Station, University of Illinois, Urbana, Ill.

"Permissible Electric Lamps for Miners," by H. H. Clark. Technical Paper 75. U. S. Bureau of Mines, Washington, D. C. 21 pp., 6x9 in.

Future Regulation of Public Utilities, by Wm. D. Kerr, Bureau Public Service Economics, 17 East Thirty-eighth street, New York City; 23 pp., 6x9 in.

"Methods of Oil Recovery in California," by Ralph Arnold and V. R. Garfias. Technical Paper 70. U. S. Bureau of Mines, Washington, D. C. 57 pp., 6x9 in.

Toronto Municipal Electric System, results for 1913, by R. P. Bolton, Bureau of Public Service Economics, 17 East Thirty-eighth street, New York City; 12 p.p., 3½x9 in.

"Magnetic and Other Properties of Electrolytic Iron Melted in Vacuo," by Trygve D. Yensen. Bulletin No. 72, Engineering Experiment Station, University of Illinois, Urbana, Ill.

RADIO EXPERTS WANTED.

The United States Civil Service Commission announces that the following examinations will be held in San Francisco at an early date:

Expert Radio Aid (male) office of superintendent of Radio Service, Naval Radio station, Radio, Va.; $8 per diem.

Expert Radio Aid (male), New York, N. Y.; Boston, Mass.; Philadelphia, Pa.; Norfolk, Va.; Charleston, S. C., and Puget Sound, Wash.; salary, $6 to $8 per diem.

Statistical editor (male and female), children's bureau, Department of Labor, Washington, D. C.; $1200 to $1400 per annum.

NEWS NOTES

FINANCIAL.

TACOMA, WASH.—The Washington-Oregon Corporation, operating power and water plants and street railway systems in Southwestern Washington and Northwestern Oregon, has been thrown into receivership. Federal Judge Cushman appointed Attorney Elmer M. Hayden temporary receiver. The receivership was asked by the Fidelity Trust Company, of Philadelphia, as trustee for a $5,000,000 bond issue. The Washington-Oregon Corporation has properties in several Washington and Oregon towns. It operates a light and power plant at Hillsboro; a light plant at Rainier; the water plant and electric street car system at Vancouver, Wash.; a power and light system at Kalama, Wash., and light plant and electric car system at Chehalis and Centralia, Wash. Isaac W. Anderson, of Tacoma, is president of the corporation, and H. G. Fleischhauer, of Portland, is general manager.

INCORPORATIONS.

SAN FERNANDO, CAL.—San Fernando Telephone & Telegraph Company, $50,000, subscribed $5000, by J. M. Baldwin, J. P. Dunn, G. S. Batty and F. A. Powell.

LOS ANGELES, CAL.—Hammond Electric Bank Protection Company, $500,000, subscribed $500, by W. D. and B. N. Hammond, C. K. Berg, F. C. Mason and A. L. Brown.

MELROSE, IDAHO.—Farmers' Inland Telephone Company has filed articles of incorporation with $2000 capital stock to build, equip and operate an independent telephone system.

RITZVILLE, WASH.—The Tannehill-Frantz Company has incorporated here with a capital stock of $40,000, the object of the company being the manufacture and sale of electric time clock systems.

PORTLAND, ORE.—That water may be furnished to residents of Green Hills and Ziontown west of the city, the Green Hills Water Company has been incorporated. Articles were filed by John Bain, H. M. Esterly, Henry Hewett, W. H. Warrens, Frank C. Kelsey, B. M. Lombard, C. Henri Labbe, Howard T. Rankin and R. G. Jubitz. The cost will be borne by all users.

SAN RAFAEL, CAL.—For the purpose of building and operating a funicular railway at Sausalito from Water street near the Ferry building, along Excelsior street to a height of 500 feet, the Sausalito Incline Street Railway Company, has been incorporated here. The incorporators are: Geo. H. Harlan, Gideon H. Smith, John Mason and Miss Belle Herzinger of Sausalito and J. W. Vance of San Francisco. The capital stock is $50,000.

ILLUMINATION.

LOS ANGELES, CAL.—The city council has promised that a system of incandescent lights will be provided for installation in the city parks.

WALLACE, IDAHO.—The annual budget passed at the last meeting of the council includes an item of $3590 for street lighting purposes.

CARRIZOZO, N. M.—It is reported that the Wild Cat Leasing Company of Wild Oaks, is contemplating putting electricity into Carrizozo both for light and power.

NOGALES, ARIZ.—The common council has deferred action in the matter of the proposed new light franchise applied for by the Nogales Electric Light, Ice & Water Company, for 6 monhts.

ANAHEIM, CAL.—The city council has decided to have a committee visit a number of Southern California cities to inspect ornamental street lighting systems for the purpose of deciding on posts and obtaining data for a system to be installed here.

LOS ANGELES, CAL.—The board of public works has awarded Llewellyn Iron Works the contract for the installation of ornamental lamp posts and electroliers on Hollywood boulevard, between Cahuenga and Wilcox avenues, for the sum of $1025.

CULDESAC, IDAHO.—The town board has granted to W. L. Marrs of Coeur d'Alene a franchise for operating an electric light plant. Mr. Marrs is to commence the work of installing the plant within the next two months, and light service will be established by October 1st.

SAN BERNARDINO, CAL.—Bids for the installation of a lighting system at Victorville have been opened by the Board of Supervisors. C. H. L. Ghriest was the only bidder and offered to maintain 100-candle power incandescent lamps at $3.72 per lamp per month. His bid was taken under advisement.

SACRAMENTO, CAL.—The Sacramento Gas Company has begun suit in the United States District Court against the city of Sacramento to prevent the enforcement of the gas rate ordinance for the present year. It is claimed the rates are confiscatory. The suit is similar to one begun by the Pacific Gas & Electric Company two weeks ago.

PASADENA, CAL.—Important improvements are to be made at the municipal lighting plant. The commission has adopted specifications for another unit to be installed. Bids for steam turbine generator and jet condenser will be received up to August 11th. According to General Manager Koiner, of the municipal plant, the contemplated improvements wil cost between $30,000 and $32,000.

PROVO, UTAH.—Within the next sixty days Provo will boast of its first "white way" and Academy avenue from Center street to First North, will be the first well lighted street in the city. The merchants have agreed to keep the lights going after their installation and steel poles have been ordered from the east for that purpose. The clusters of lights will be similar to those used in Salt Lake.

SALT LAKE CITY, UTAH.—No attempt will be made by the city commission to carry into effect the lighting district law passed by the last legislature. Accepting the opinion of the city attorney that the enactment is so "full of holes" that it would be foolish to act under it, the commission declined to test out the law as was desired by the state improvement league. Instead, the city attorney was instructed to prepare a bill for the next legislature overcoming the defects found in the present law. The intent of the law is to allow the city to create special lighting districts and assess the cost of improved lighting systems to abutting property owners, after the manner in which other street improvements are made. The law failed to specify the manner in which the assessment might be levied and was generally defective in its working provisions, according to the attorney.

TRANSMISSION.

BRUNEAU, IDAHO.—The Electric Light & Power Company intend building an electric transmission line from this town to Glenn's Ferry.

HAILEY, IDAHO.—The Hailey Electric Company is extending its lines to Ketchum so as to supply electric light and power to that town and vicinity.

PRINCE RUPERT, B. C.—Prince Rupert is fighting the entrance of the Prince Rupert Hydroelectric company The municipality is building a system of its own and for this reason does not desire a privately-owned concern as a competitor.

ELLENSBURG, WASH.—Malcolm McLennan and R. B. Wilson of this city have given an option on 400 acres of land adjacent to the Priest Rapids power plant of the Pacific Power

& Light Company to Ernest Plummer, who it is thought is acting for the power company.

LOS ANGELES, CAL.—Suit has been brought by F. E. Hartigan to enjoin the city from using any of the $6,500,000 bonds voted last May on the ground that the combination issue for the completion of the power plant and the construction or acquisition of a distributing system, was illegal.

TACOMA, WASH.—Mutual Electric Light & Power Company, by O. R. Kinney, president and A. Westbo, secretary, has filed application with the county commissioners for a franchise on Pioneer way and other roads in Puyallup valley for the extension of electric lines to furnish current for electric light and power for a farmers' telephone system.

BOISE, IDAHO.—The Idaho-Oregon Light & Power Company, with headquarters in this city, has resumed work on its Oxbow plant, the construction of which has been held up for a long time owing to the financial difficulties of the company. Receiver Ferris of the company has recently completed arrangements for the installation of 1-3600 k.v.a. Westinghouse electric generator in this station and it is expected that the unit will be ready for operation within thirty days.

PHOENIX, ARIZ.—To dam Little Colorado River two places near Tolchaco, to build power houses and 175 miles of transmission line to Globe, Ray and Hayden, and to produce electricity from most useless streams in Arizona, is the plan contained in voluminous filings of F. G. Baum, Special engineer from San Francisco, who has applied for a power permit in the United States Land Office. Little could be learned concerning Baum's backing in this projcet.

LOGAN, UTAH.—In consequence of an application by the Logan Mutual Power Company to the state engineer for 125 second feet of water to be taken from the north forks of the Logan River for power purposes, the people of this city have become considerably disturbed. The property owners are filing protests which claim it would mean the preemption of the entire stream by pipe line 18 miles in length, thus transforming what they claim to be one of the most beautiful and scenic water courses in the state into a dry barren and unattractive gorge. The company filed application last December, and the time for the protest expires within the next few days.

SPOKANE, WASH.—The Spokane Valley Power Company has petitioned to develop a site at the Bowl and Pitcher now held by the Spokane & Inland Empire System who give the reason for non-development that they are purchasing power from the Washington Water Power Company under a contract made prior to securing the power site and which does not expire until 1916, at an annual cost at $76,000. The Spokane Valley Power Company contend that the transportation has no right to hold so valuable a power site without developing it, the opposing argument being that in view of the existing contract there would be no immediate advantage in prosecuting the development.

RENO, NEV.—W. H. Leffingwell, chief engineer for the Canyon Power Company, which has leased the power plant constructed by the government at the Lahonton dam, with Edson F. Adams and C. F. Cole, arrived from Bishop, recently, where several days were spent in going over the various districts withthe view of securing information regarding mining districts that are now in the course of development and which can be regarded as future consumers of electric power. Both Mr. Adams and Mr. Cole are heavily interested in the power company. According to the plans of the company power lines will be extended from the Lahonton plant to Hazen and Lovelock, taking in various mining districts. It is intended to supply territory now dependent upon power other than electricity, for the development of mining interests and other industries. Mr. Leffingwell says; "The work of constructing the power lines will be undertaken at once. We expect to have practically everything in readiness by the 1st of December. This will include not only the erection of lines, but the arrangements to enlarge the plant if that is found to be necessary. The Lahonton power plant was constructed by the government for the purpose of furnishing power and lighting facilities while the work of building the dam was in progress. A contract was also made with the town of Fallon for furnishing power to that city and at this time Fallon is the only private consumer of the enterprise. The Fallon contract will be taken over by the company.

EUREKA, UTAH.—Work is soon to started on the splendid new substation that the Utah Power Company will erect in this district. The new building, which will be about 50 by 70 ft. in size, will be erected on ground that the power company has purchased from the Chief Consolidated Mining Company, and the equipment that is now in the substation, near the Colorado mine, will be moved to the new location. Linemen are now at work changing the pole line and getting everything in readiness for bringing the power into the new substation. They are also reconstructing the "Knight" line into Tintic, removing the steel crossarms and replacing them with wooden crossarms. The power company has had trouble with this line and it is thought that the wooden crossarms will improve the service materially.

TRANSPORTATION.

BELLINGHAM, WASH.—It is reported practically all of the right-of-way for the Blaine-Lynden interurban railroad has been secured. The Blaine City council has granted the company a franchise over its streets and a like franchise has passed first reading before the Lynden city council.

VISALIA, CAL.—Work has been started on a three-mile extension of the Visalia electric railroad from Woodlake to the base of the foothills. The new construction will open up 1000 acres of land, a large portion of which is considered the equal of the best orange acreage in Tulare county.

PORTLAND, ORE.—After increasing the annual rental for use of the streets, the city commission put its approval on the 25 year franchise sought by the Portland & Oregon City Railway Company, for an interurban line through the east side to connect with a line being built from Oregon City to Portland.

SAN FRANCISCO, CAL.—The Daniel O'Day Company has been granted a permit to lay down tracks and operate cars with electricity by means of an overhead trolley system on the north sire of Mariposa street from the east line of York street, to connect with the main line of the Ocean Shore Railroad, and to lay a temporary spur track on the west line of Hampshire street from a connection of the temporary spur track on Mariposa street.

SEATTLE, WASH.—An offer to the city of the Loyal Heights Railway System for the sum of $80,057 has been received by the council. Harry Whitney Treat, owner of the railway agreed to accept utility bonds in payment. The price asked is said to represent the construction cost of the road including right-of-way and equipment. No valuation has been placed upon the franchise. It is proposed that the extension of the municipal system of division A connect with the Loyal Heights system.

SALT LAKE CITY, UTAH.—Electric service was inaugurated on the Salt Lake & Utah Railroad (the Orem Line) on Friday, July 24th, between Salt Lake City and Provo, a distance of 48½ miles. The road beds for this line were completed early in the season and steam service was installed pending the delivery and installation of the electrical equipment. The installation of this electrical equipment was made in record time, the apparatus for the two substations, outdoor switching stations, limbering up and testing out having been made in six weeks. The equipment whch was furnished by the Westinghouse Electric & Manufacturing Company, was installed by the Westinghouse service department under the direction of M. R. Davis, district superintendent, with headquarters at Salt Lake City.

ALPHABETICAL INDEX TO ADVERTISERS

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B-1 Benjamin Electric Manufacturing Co.....
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B-3 Blake Signal and Manufacturing Co.....12
680 Howard Street, San Francisco.

B-5 Bridgeport Brass Co.....16
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B-6 Baruch Electric Controller Corporation.....11
424 Thirteenth St., Oakland, Cal.

B-7 Busch-Sulzer Bros.-Diesel Engine Co.....11
Rialto Bldg., San Francisco.

C-1 Century Electric Co.....12
614 South Grand Avenue, Los Angeles; 56 Natoma Street, San Francisco; Seattle; Spokane.

C-2 Colonial Lamp Works.....
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C-3 Crocker-Wheeler Co.....
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N-1 Nason & Co., R. N.....
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S-6 Standard Underground Cable Co.....
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56 Natoma Street, San Francisco.

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W-2 Western Electric Co.....
119 East Seventh Street, Los Angeles; 507 Sixteenth Street, Oakland; 680 Folsom Street, San Francisco; 907 First Avenue, So., Seattle.

W-4 Westinghouse Electric and Manufacturing Co.....
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